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SURFACE SHIP OVERHAUL DECISION ANALYSIS

by

John Bigelow Perkins

December 1992

Thesis Advisor: Lawrence R. Jones

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Surface Ship Overhaul Decision Analysis

by

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Submitted in partial fulfilment
of the requirements for the degree of

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ABSTRACT

Efficient Surface Ship Maintenance and repair is vital to the U.S. Navy. With defense budgets tightening, accurate and economically sound decision making in this program is essential. To improve decision making, it would be helpful to have an accurate analysis program to evaluate the adequacy of ship maintenance and repair decisions. This system should use available overhaul information to identify errors made during the overhaul process. This thesis analyzes current Navy ship maintenance and repair feedback processes to determine if any system is used presently that adequately measures the accuracy of decisions made within the Surface Ship Maintenance Program. Further, this thesis develops an Overhaul Decision Analysis Model to assess the present Navy Surface Ship decision process. Finally, this thesis draws conclusions based on application of the model. These findings address both cost and equipment readiness issues to demonstrate the benefits of an effective Surface Ship Decision Analysis Program.

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TABLE OF CONTENTS

I. INTRODUCTION

A. STATEMENT OF THE PROBLEM

One of the critical problems for the United States Navy is sustaining proper levels of support for the surface ship maintenance program. This program is the cornerstone for maintaining surface ships at the highest level of readiness. Without this program shipboard engines, guns, missiles, and all other "breakable" systems would have less reliability, and higher failure rates. The ability for the U.S. Navy to carry out its assigned missions can be viewed as partly a function of material readiness. The U.S. Navy's mission readiness is inextricably tied to the surface maintenance program. This fact underscores the importance for the surface ship maintenance program to be both <u>efficient</u> and <u>proficient</u>. The surface ship maintenance decision process used to decide the work to be accomplished during overhauls, is complicated in part due to the number of separate organizational entities required to plan and carry out depot level maintenance. The number of organizations required to execute each specific overhaul depends on the type of maintenance philosophy employed by the ship undergoing the overhaul. Currently, the Navy has three major maintenance philosophies:

1. Engineering Operating Cycle. The Engineering Operating Cycle (EOC) is a type of maintenance strategy that establishes a structured approach for designated surface ships on a 5-7 year operating cycle. During the five to seven year engineering cycle each ship is assigned one interdepolyment Selected Restricted Availability (SRA)[1]. Further, each ship has two Intermediate Maintenance Availability's (IMAV)[2] per 5-7 year cycle. Lastly each cycle has one depot level availability per cycle that allows major shipyard jobs to be accomplished. The EOC program has specific documents used in planning the depot level availabilities.[Ref 1] They include:

- The Consolidated Ships Maintenance Document (CSMP). This is a list of corrective and preventative maintenance actions entered mainly by ships force into the 3M system[3] .

- The Class Maintenance Plan (CMP) is a time directed maintenance plan that attempts to predict required maintenance during a ship's operating cycle.

These two documents are the main documents used in creating the Ships Alteration and Repair Package (SARP) [4]for the EOC program. The SARP is the key document used by the Planning & Engineering for Repair and Alterations organization (PERA) to list the jobs that have been assigned for repair during an upcoming availability.

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[1] Selected Restricted Availability, "SRA", is an operational availability that allows for repairs inport over a 6-12 week period.

[2] Intermediate Maintenance Availabilities, "IMAV's", are periods of time when ships have time available for maintenance work to be accomplished by Shore Intermediate Maintenance Availabilities SIMA's or destroyer tenders.

[3] 3M stands for Maintenance Material and Management system used in the Navy to control equipment repair, and manage preventative maintenance fleet-wide.

[4] Ship Alteration and Repair Package, "SARP", is a document generated by PERA that lists the jobs and job specifications for all work to be accomplished during a planned overhaul period. There are different specific SARPS (e.g. authorized or completion) compiled at different points during an availability cycle. The specifics of individual SARPS is addressed in chapter I subsection D.

2. Progressive ship maintenance. The progressive ship maintenance program is a strategy that supports limited manned ships. (for example FFG-7) Limited manned ships are structured for component removal and replacement. Further, these ships are designed to have a large majority of maintenance and repair accomplished at depot levels due to the reduced manning levels of these particular ships. The progressive maintenance system, like the EOC program, uses CMP's and CSMP's as sources for their SARPS. But unlike the EOC system the progressive system uses rotatable pools of equipment. These rotatable pools of equipment are pieces of machinery that have been identified by engineering analysis to require changeout on a time directed basis. The machinery that is identified is then replaced during IMAV's and SRA's to minimize the maintenance requirements on these reduced level shipboard organizations. [Ref 1]

3. Phased Maintenance Program (PMP). The phased maintenance program (PMP) is a maintenance strategy that accomplishes depot level maintenance through a series of short Phased Maintenance Availabilities (PMA's) in place of Regular Overhauls (ROH's)[5]. The emphasis of this program is to use condition directed repair. To this end, the PMP does not use a CMP, as this document works by recommending jobs on a time directed basis. The main factor in deciding what material is to be repaired is the **actual** material condition of each piece of equipment. Only necessary repairs are authorized and accomplished. This strategy differs from the time directed philosophies of the EOC and progressive maintenance strategies. The PMP strategy also differs from the EOC and progressive strategies by assigning an additional experienced, professional engineer to help administer and coordinate each overhaul. This expert, known as the Port Engineer, remains with the same ship class throughout the planning and execution cycle of each ship overhaul.[Ref 1]

The environment within which the surface ship maintenance program must operate at present is somewhat uncertain. This uncertainty stems from the reduction in funds that every DOD

[5] Regular Overhaul, "ROH", is a period of time when a ship effects repairs or alterations at a shipyard (either public or private). [Ref 1]

program will have to contend with in the near future. Budget reduction also could mean restructuring in order to save money. This restructuring could mean for example, that the Port Engineer presently responsible for only those ships that are under the phased maintenance program, could be responsible for all of the ships going through any type of depot level maintenance. Consolidation of duties within the surface ship maintenance program is a process that could be used to save funds.

Another area of financial concern is simply the amount of money that will be allocated for overhauls to each ship. As an example an ROH for a typical modern destroyer can cost up to thirty million dollars or more. With budgets tightening, each ship may be required to complete overhauls with less money.

With this in mind, decisions which maximize the efficient use of resources must be made. Most of the critical planning decisions are made at what is called the Work Definition Conference (WDC). The WDC is a meeting in which the major players of an overhaul decide what jobs will be accomplished and which ones won't. The major players for the EOC include: (PERA), the Type Commander (TYCOM), ship's company and Supervisor of Shipbuilding Conversion and Repair (SUPSHIPS).

The output document from this meeting is the authorized Ships Alteration and Repair Package (SARP). The WDC, by definition is the point where material repair requirements meet cost constraints. The WDC then becomes the focal point to determine whether the decisions made within an overhaul are both correct materially as well as economically.

In summary, the surface ship maintenance program finds itself in a difficult transition period. The responsibility that it has always had, to maintain U.S. Naval ships at 100% mission (material) readiness, has not diminished. However, the materials and assets that the system has at its disposal to accomplish its mission will not be the same in the near future. First, it is almost a sure thing that the amount of money per overhaul will be reduced. Secondly, it is a strong possibility that restructuring and consolidation within the surface ship maintenance program will become a reality. This could leave the program with less organizational support.

The Surface Navy Maintenance Program, even with the reduction in assets available to it, cannot afford any reduction in the quality of each overhaul. Any degradation in the ability of the Surface Navy Maintenance Program to properly execute shipyard overhauls would translate into a Navy that is less then 100% ready to meet mission requirements. This is an unacceptable alternative. The only other option is to use limited resources more economically. This could be done by making the money go farther within each overhaul, and by using the information generated from overhauls more effectively. Budget reductions and reorganizations <u>are</u> coming; therefore, better decisions must be made or the result will be a materially deficient Navy.

B. DEVELOPMENT OF THE RESEARCH QUESTIONS

Any decision making process must use all of the available information in order to increase accuracy, and efficiency. The surface ship maintenance program managers must make numerous decisions for each major overhaul of ships under their control. As described earlier, decisions are usually made within the Work Definition Conference (WDC). The decisions are made using inputs collected from sources such as the ship's CSMP, PMT reports,[6] Class Maintenance Plans, expert organizations (PERA & SUPSHIPS) and other sources. All of these sources are used during the WDC to make the authorized SARP. It is interesting to note that all of the input sources for the SARP are compiled specifically from and for each individual ship's overhaul. However, none of the major input items used are considered "lessons learned" from previously completed overhauls. Feedback from previous endeavors could be a key element in the improvement of the ship overhaul decision making systems. It follows then that improvements within the Surface Ship Maintenance Program could come through

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[6] Performance Monitoring Teams, "PMT's", are teams that visit ships in order to evaluate machinery condition by using vibration analysis and other performance monitoring procedures. A more detailed explanation is presented in chapter II.

development of a more effective post availability assessment system. With this in mind the primary research question for this thesis is:

How does the Navy assess the adequacy of ship maintenance in the post-availability period, after repair has been completed?

A secondary question is:

Is the existing assessment process suitable to judge the correctness of the planning decisions made for ship's maintenance and repair?

The answer to these questions may provide improvements to the current overhaul assessment system. Such improvements in efficiency could result in budgetary as well as material savings. The end goal is to improve ship maintenance and repair.

C. METHODOLOGY

To begin with, this thesis will provide a detailed summary of the current feedback systems presently in use within the U.S. Navy. This first section will review each system and analyze each one to determine if any of these systems adequately measures the decision making process by using after overhaul data. The process of presenting existing Navy overhaul systems will consist of learning about the systems from the Naval organizations who run the systems. This will include a detailed study of the documents used as the sources of data for each system. Next, a description of the actual system and how it is operated will be presented. From this information a large part of the research question should be answered.

Once the results of this analysis is completed, this thesis will attempt to improve upon the existing feedback systems by constructing and executing an independent feedback model. Most of the basic data for this model will be gathered from output documents provided from the post overhaul period of six ships that have recently finished Regular Overhauls (ROH). Other data will be gathered through field interviews, published articles, and professional Naval instructions all pertaining to the maintenance process. Research for the model will be conducted in seven major steps:

1. Data will be collected from six ships to include: the authorized or completion SARP, all Casualty Reports recorded by the ship during the six month period immediately following the completion of each overhaul, the PMT post overhaul Executive Summary for all ships that had this particular report available, and the engineering inspection results that are routinely generated by the Propulsion Examining Board (PEB) immediately following a yard period. Specifically, both the Light Off Exam (LOE) and the follow on Operational Propulsion Plant Exam (OPPE) will be used as sources of the feedback system. The post overhaul information (specifically the CASREPS, PMT results, and the LOE/OPPE results) will be compared to the SARPS of the same ships. The result of this comparison will be a documentation of decision errors made during the WDC that resulted in an equipment failure in the after overhaul period. This procedure may be considered as a possible model for a post overhaul analysis system.

2. Interviews will be conducted with Naval Sea Systems Command Detachment, PERA (Surface),code 510; Naval Sea

Systems command (NAVSEA) (SEA-915/935); Commander Naval Surface Force Pacific (CNSP) (N-4);Commander Naval Surface Force Atlantic (CNSA) (N-4), Port Engineers (N4PE); and Naval Sea Systems Command (AEC Pacific Fleet) Naval Ship Systems Engineering Station (NAVSSES) code 101b1.

3. An examination of the process involved in the preparation of changes to Class Maintenance Plans for specific ship classes will be performed.

4. The process of Assessment of Equipment condition (AEC) in generating Ships Maintenance Action Form (SMAF) reports will be examined.

5. An examination of the process of the Measures of Effectiveness (MOE) program operated by NAVSSES Philadelphia will be accomplished.

6. The Trouble System operated by the TYCOM surface forces will be reviewed.

7. An evaluation of the NAVSEA operated Maintenance Requirement System (MRS) will be performed.

The above research will evaluate and critique the feedback procedures currently used by the Navy to evaluate and improve the decision making within the overhaul ship maintenance and repair system. Further, this thesis will draw conclusions from the data collected by the model in order to present options to improve and consolidate Navy wide post overhaul assessment.

D. AVAILABLE INFORMATION

This section outlines the types of available information that are to be used to provide feedback, and the systems used to collect this information.

1. Authorized SARP:

The authorized SARP is a result of the Work Definition Conference (WDC) and a product of PERA. "It lists the work package that has been authorized and screened to the various repair activities including ship's force, IMA ETC., **and that work which was considered and deferred**"[7] . The inputs for the authorized SARP include: CSMP's, CMP's and the Pre Overhaul Test and Inspection (POT & I)[8]. The authorized SARP is the first piece of data that can be used to document items that were not authorized, or deferred, due to decisions made in the WDC. This document can be compared against any other post overhaul information. The resultant data can be used to list decisions that were made at the WDC that resulted in material problems in the post availability period. In short, the authorized SARP is one of the best documents that can be used as a baseline for any post overhaul analysis system. This information is contained in two forms. It originally is printed in binder form and distributed to all of the major players to be used during the overhaul process. It is further stored on computer tapes that can be down loaded onto PERA's

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[7] PERA code 510, NAVSEA, Completion SARP, Glossary section page 2.

[8] Pre Overhaul Tests and Inspection, "POT & I", is a series of tests and inspections of equipment and machinery accomplished prior to the WDC that identify items that require repair, and should be considered for possible addition to the work package.

Vax computer for analysis or used as input data for PERA's corporate database. [Ref 2]

2. Completion SARP:

The completion SARP is the document compiled and distributed by PERA after the overhaul is complete. This document shows the items that were both completed and not completed for whatever reason. Further, this document lists any additional work to be accomplished on an already approved job as well as new jobs added after the WDC. These two items are called "growth and new work". The most valuable piece of information that this document provides is cost. The completion SARP lists total costs as estimated by SUPSHIPS. Further, the completion SARP lists mandays per job. This shows the amount of time that was used for completion of each job. These data can be very important in measuring the economic efficiency of each repair as measured against similar repairs on other ships. The data for the completion SARP is maintained in the same manner as for the authorized SARP. One difference between the two SARPS is that PERA does not always compile the completion SARP as it does for the authorized SARP. This is because the cost for the completion SARP must be authorized by the Type Commanders (TYCOMS). The TYCOMS are not always willing to pay for this service. This means the data is not always available. If the data is compiled for the completion SARP, then its information is stored on magnetic tape and also is used in the PERA corporate data base.

3. Casualty Reports:

Casualty Reports, commonly referred to as CASREPS, are reports that detail equipment casualties on individual ships. When ships have an equipment failure that is beyond ships force capability to repair, so as to achieve some degree of mission readiness, one option available is a CASREP. CASREPS are reported by a variety of fields. These fields include ship name, Equipment Identification codes (EIC) [9], CASREP severity, parts required to effect repair, and the written description of the specific problem. These reports are compiled into two different data bases. The first one of these is maintained by Ships Parts Control Center (SPCC) Mechanicsburg. The information from Mechanichsburg is be dispersed to different organizations through out the Navy by computer tape and/or paper reports. Another system that stores and collects CASREP information is the Type Commander Headquarters Automated Information System (THAIS). This system is a classified LAN that receives inputs from communication Stations and thus maintains virtually real time CASREP information available for the Type Commander. This is

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[9] Equipment Identification Codes, "EIC's", are alpha numeric numbers used within the 3M system to identify specific systems with regard to the maintenance being performed.

an advantage over the SPCC CASREP data because the SPCC data has a lag time of approximately three months. [Ref 3]

The point is that CASREP information shows mechanical problems that arise during a post overhaul period. These data then can be compared to a designated baseline data set, such as an authorized SARP, so as to evaluate the decision making process within the WDC.

4. PMT reports

Performance Monitoring Teams (PMT'S) are groups of Naval engineers highly trained in mechanical analysis, who ride ships evaluating the material condition of a large majority of ship board equipment. The actual methodology involves use of Machinery Condition Analysis (MCA). MCA is a system that evaluates machinery through vibration analysis (MVA) coupled with expert observation. The evaluation of the data gathered by the PMT teams is analyzed by the Assessment of Equipment Condition (AEC) organization and a report is generated. This report, called an Executive Summary, lists each piece of equipment by both SWAB number[10] as well as by noun name. Further, the Executive Summary also gives an overall condition description (poor through excellent), for each piece of equipment tested as well as a recommendation as to what level of repair the item should be repaired. [Ref.4]

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[10] SWAB# is a numbering system that groups systems so as to facilitate packaging of similar jobs for depot level work [Ref 1].

Another way that PMT teams track defective machinery is through Shipboard Maintenance Action Forms (SMAF'S). SMAF's are computer generated forms from organizations other than the ship that automatically enter jobs into a particular ships CSMP. (examples of organizations that use SMAF's are AEC and INSURV).

The PMT teams normally plan to accomplish ship visits both prior as well as following each major overhaul. The post overhaul Executive Summaries are designed perfectly for use as a post overhaul data source. The Executive Summary information is originally sent out in message format; however, the AEC has a Vax computer in which all data is compiled from all ship visits. This AEC computer has many different program applications that allow data to be manipulated to fulfill various requirements. [Ref 4]

5. PEB Test Results

The requirements for any U.S. Naval ship coming out of overhaul include two engineering tests. The first is called a Light Off Exam (LOE). This is an exam that measures the readiness of Naval vessels preparing to commence underway operations immediately following undocking. The LOE is usually at the beginning of the post availability period. It focuses on material condition making it excellent as a limited view of items repaired.

The second exam associated with overhauls is the follow-on Operational Propulsion Plant Exam (OPPE). The OPPE is the same type of exam as the LOE except it is conducted while the ship is underway. This post overhaul OPPE is conducted approximately six months after the completion of the LOE, and as such is one of the latest pieces of data that could be collected and considered as post overhaul data. Both of the results of these tests are initially distributed in message form. The results are also stored for review by the inspecting authority (the Propulsion Examining Board (PEB) on their own computer though only PEB members can access the data However, the rough notes of the inspectors are stored to give a detailed description of any discrepancies found and are available upon request. The inspection message results also list the results in a Pass/Fail format with amplifying remarks. If the ship fails the inspection in whole or in part due to material considerations, this will be disclosed in the amplifying remarks. Pass or fail, the inspection results are important sources of post overhaul information.

6. "As Found Condition" Reports

"As Found Condition" Reports are documents that list conditions found when machinery is opened for repair. These reports are filled out by contractors as they disassemble machinery on which work is required. This information is used to gauge whether assumptions of material condition predicted by Class Maintenance Plan's are correct and as such become an excellent source of feedback data. The feedback reports are filed and stored in paper form at PERA Surface. This particular feedback source is not entered into any computer data base.

7. Departure Reports

Departure Reports are documents that list all work that was both accomplished and not accomplished (after being authorized at the WDC.), growth in work during the availability, and new work added at the finish of the drydock period. Departure Reports document various items that could be used in feedback systems. First, these reports show reasons why items were approved in the WDC but then not accomplished during the overhaul. One reason that this type of situation would occur is due to material unavailability forcing a WDC authorized job to be not accomplished. Second, Departure Reports list Growth and New Work. The definition of growth and new work are those jobs expanded or added after the Work Definition Conference (WDC). These reports are generated by SUPSHIPS and are dispersed to users via paper report. The data from this report is stored in a computer operated by SUPSHIPS.

8. CSMP Information

CSMP data is important information to any feedback system because, unlike all of the other data previously mentioned, it encompasses all of the jobs that have been requested to be accomplished by any particular ship. By definition, the **Current** Ships Maintenance Document (CSMP) contains **all** jobs necessary to bring a particular ship up to 100% mission readiness. CSMP data includes those jobs possibly scheduled for ship's force. Unlike CASREP data, which usually gives only specific information on those items that were unable to be repaired by ship's force, and, as such, could omit critical information. Another reason that CSMP data is important to any post overhaul analysis system is that the CSMP is the main input document in SARP creation. CSMP data is stored shore-side primarily with the Maintenance Resource Management System (MRMS). [Ref. 1]

Maintenance Resource Management System (MRMS) is the TYCOM computerized system for managing the Navy CSMP on a fleet-wide scale. This system allows the TYCOM representatives to receive work requests, update CSMP files, and call down or screen specific jobs to the appropriate repair facility. MRMS data is available to any organization that is connected (TYCOM et) to the system via computer hookup. One organization with MERMS access is PERA Surface at Philadelphia, PA. The PERA MRMS hookup is used to down-load CSMP during SARP creation. MRMS information is also available by modem, magnetic tapes, or floppy disks. [Ref. 1]

9. Combat Systems Tests and Inspections

Combat Systems, like the engineering departments, has a series of tests and inspections including: the Combat Systems Assessment (CSA) and the Combat Systems Readiness Review (CSRR). Both of these tests use MRC cards as a measure of how well each combat system is performing as compared to parameters determined in each MRC. Each of these inspections produce lists of equipment that have mechanical deficiencies. These inspections, if occurring close to the finish of an overhaul, could be used as feedback data. The data is compiled and kept by the TYCOMS and stored in a computer, as well as in paper form.[11]

10. INSURV

In Service Inspections (INSURV) is a ship-wide test that is accomplished every two years. The results of this test give a good overview of the ships condition. If the inspection occurred shortly after the completion of a overhaul, this data could become extremely relevant. The data of deficient information is kept both at INSURV headquarters as well as in the inspected ships CSMP via SMAF reports (See PMT explanation).

In conclusion, this chapter has defined the research questions and the benefits derived to the Navy in overhaul

[11] These inspections are used in a feedback system called "The Trouble System" that will be detailed in chapter II.

planning. Next, the principle elements within the surface ship maintenance program were defined. Lastly, the information available for the feedback system was presented. This information will now be used to discuss the feedback systems outlined in chapter II.

II. PRESENT U.S. NAVY INDUSTRIAL REPORT FEEDBACK SYSTEMS

A. COMPLETION SARP/ POST AVAILABILITY ANALYSIS REPORT & CORPORATE DATA BASE

One of the most important elements of data that can be collected for use as post overhaul information is cost. The reason for this is that cost data can be used to gauge whether subsequent overhauls are as cost efficient as preceding ones or not. The information that is recorded in the completion SARP contains both final costs as well as mandays used to complete each job. This information is then recorded from the completion SARP into both PERA's corporate database as well as the Post Availability Analysis Report.

Other inputs into the PERA corporate database include:

1. PERA data source files - e.g. PERA SARP System, NAVSEA Availability file, SPCC Maintenance data system.
2. General Information Files - e.g. Ships Information, General Ship Catalog, Ship Availability Catalog.
3. Availability Historical Files - e.g. TYCOM Repair cost, PERA Planning Data, NAVSEA Modernization Cost Data.
4. Industrial Files - e.g. Industrial activity current cost.
5. Equipment History Files - e.g. SARP Authorized/Completion Cost Data, Ships Force Equipment History.
6. Diagnostic Files - e.g. MCA, Ultrasonic Survey, Infra-red Surveys.

PERA's Corporate database is a computer software program that is physically located in Norfolk VA, funded by SURFLANT but operated by PERA Surface. ALL of the PERA Surface organization have access to the database. Therefore the data base maintains all overhaul and costing data for surface ships fleet wide. [Ref. 2]

The corporate database is used to predict both costs as well as time (mandays) per job type. This information can be compiled by ship-class or by individual ship. With this information PERA overhaul planners can better estimate individual equipment as well as total ships cost for overhaul. The data compiled by the corporate data base also can be used to measure the efficiency of shipyards used for Naval overhauls. The database can be used to query costing data by shipyards. The obvious use for this information is in choosing the most economic shipyards to accomplish overhauls. [Ref. 2]

The information gathered by Completion Sarps and compiled into the corporate data base is used in the decision making process at the WDC as well. Sometimes the estimated costs of a particular job as listed by the shipyard appear high. These figures can be compared to the costs in the information gathered in the corporate data base. Some increase in costs per job and rate are to be expected over time due to inflation. However, the mandays per particular job should not change. The reason for this is that shipyard workers should complete similar jobs in similar amounts of time, regardless of the location in which the repairs are effected. For example, if a particular job is recorded in the corporate database as accomplished using only ten mandays, then the shipyard contractor should come in with a bid that is very similar. This manday data is very useful when trying to ensure that the contractors are not attempting to pad budgeted prices through artificially high manday estimates. The corporate data base showing manday figures from comparable past overhauls can help during negotiations in maintaining cost efficiency. [Ref. 2]

The completion SARP, along with providing part of the information for the corporate data base, is also the source for another post overhaul feedback system. The document produced by this information is called the Post Availability Analysis Report (PAAR). The PAAR report extracts data from the Completion SARP and compiles the data into the following subject areas:

1. Overhaul Planning and Execution. These sections give an overview of the planning, key events, scheduling factors, and analysis of significant growth and new work.

2. Recommendations and Lessons Learned from the Overhaul. This section is in paragraph form and includes recommendations that may include, but are not limited to, items that can improve timely and successful overhauls, SHIPALT installation timeliness, space turnover, government furnished materials, etc.

3. Appendices. This section is reserved for comparisons of costs between ships undergoing similar overhauls. These cost comparisons compare and contrast overhaul costs per ship broken down into totals spent by both Tycom and NAVSEA as well as by overall costs.

4. Reports. The reports generated in this part of the reports compile data to include customer funds summary, work package summary, increased repair cost report, percent growth report, and work package report. These reports can be very important when looking at how well cost planning was able to estimate actual costs (primarily through reports such as increased repair cost reports, percent growth etc.).

The PAAR reports are excellent forms of feedback that serve to document and store both lessons learned and actual costing data. Further, the PAAR is well suited to analyze and compare overhauls both from a procedural as well as cost viewpoint.

B. ASSESSMENT OF MATERIAL EQUIPMENT (AEC) AND PERFORMANCE MONITORING TEAM (PMT)

The Assessment of Material Condition (AEC) takes the inspection findings gathered by the Performance Monitoring Teams (PMT's), analyzes the findings and distribute the results in the form of Executive Summaries. These Executive Summaries report for each individual piece of equipment results of the following tests and recommendations:

1. Machinery Vibration Analysis (MVA). Machinery Condition Analysis (MVA) is one of the tests that the PMT teams perform when conducting ship visits. If the vibration of the equipment being tested is above set parameters, this is often indicative of a piece of equipment that is ready to fail. This test is

considered one of the most important segments of a PMT ship visit.

2. Performance Test. The performance tests conducted during ship visits gauge whether the machinery being examined is operating according to specifications as laid out in technical manuals and PMS checks. These tests, like the MVA tests, are crucial in making conclusions on overall machinery condition.

3. Ship's Force Self Assessment. This is simply an adjective assessment by ships force for all pieces of equipment that are tested during PMT ship visits.

4. Condition Assessment. This section reports the results of the AEC analysis of the previously collected data. First, like the Ship's Force Self Assessment, an overall descriptive adjective is assigned to each piece of machinery. This description ranges from excellent through poor, and gives all interested parties a one word specific value that can be used in maintenance decisions.

The next part of the condition assessment section gives AEC recommendations for maintenance on equipment. These AEC recommendations are really suggestions for the organizations (For example: PERA and TYCOM) that screen and decide where the maintenance of Navy equipment will be accomplished. The AEC recommendations can either support an already existing CSMP maintenance action (listed by job control number or JCN[12]) or recommend deferral or even cancellation for those items deemed unnecessary with regard to the results of the Executive Summary. The Performance Monitoring Teams are supposed to

[12] Job Control Numbers, "JCN's", consist of a Unit Identification Code (a number identifying a command such as a ship in the Navy.), a work center identification number, and a sequential number that identifies the exact job that is being submitted into the 3M system (CSMP).

conduct ship visits both prior to the Work Definition Conference as well as within six months after the overhaul is complete. The significance of these visits (called pre and post visits) is that they can be used to help make better maintenance decisions during the WDC, and to evaluate those decisions as a post overhaul assessment system.

With each Executive Summary the AEC includes a list of Ship's Maintenance Action Forms (SMAF's). These documents, as listed earlier, are recommendations on equipment that, from AECs perspective require some sort of repair. The documents are automatically entered into the inspected Ship's CSMP by the SMAF report. These CSMP entries can then be looked at during the WDC for possible jobs that should be accomplished during the upcoming overhaul. [Ref. 4]

The post repair PMT visit allows ships to have an assessment of the repairs accomplished during its overhaul. If the post overhaul AEC executive summary shows numerous pieces of equipment as being evaluated as poor, then it is possible that the decision making process for the overhaul may have been faulty. This would be highlighted by both pre and post executive summaries having much the same equipment being listed as "poor".

Like the post and pre Executive Summaries, the AEC computer can be used as a post overhaul analysis system. All of the data collected by the PMT visits and analyzed by the AEC organization is down-loaded into the AEC Vax computer.

The specifics for each piece of machinery is loaded into the material history section of the software. This application allows all of the test results conducted to be documented into a computer data base. If this data is entered accurately then this menu on the AEC computer could easily track the maintenance progress of equipment through any ships overhaul. This material history section could easily highlight any equipment that had been identified prior to the start of overhaul as requiring maintenance, submitted as a SMAF, and then rejected at the WDC for whatever reason. [Ref. 5]

Another application within the AEC computer that could track and assess decisions made during an overhaul is called the SMAF query. With this function it is possible to direct the AEC computer to list all outstanding SMAF's at any time period. This allows the AEC to keep track of all of the recommendations that were made for each individual ship visit. If a recommendation was made and entered into the system via a SMAF during the post (or pre for that matter) overhaul visit, and the same piece of equipment had been turned down for overhaul during the recently completed yard period, then this procedure could be used as an overhaul assessment procedure.

There are problems, however, with AEC ability to use their Vax computer as a feedback system for overhauls. To begin with, the data entered into the material history menu of the AEC computer is not always accurate. The source of the inaccuracies ranges from outdated information to erroneous entries made for specific pieces of equipment. The AEC organization relies on the PMT visits for all of the information that is stored in the material history computer files. This means the information is only as accurate as the last PMT visit. Even though PMT visits are supposed to occur on a quarterly basis, they are frequently canceled or not scheduled due to operational requirements, and as such the length of time between visits can become quite long [Ref. 4]. Secondly, when the information is recorded into the 3M system, the entries maybe made incorrectly. Many times the individuals entering the data do not realize the importance of recording a proper serial number or Equipment Identification Code (EIC) for a piece of equipment. These two problems damage the reliability of the conclusions drawn from the material history computer file. [Ref. 5]

Like the material history file, the Outstanding SMAF reports system has problems as well. At the present time, the AEC does not have access to CSMP data (**at present**, their computer is not linked through MRMS or any other 3M source). Therefore,if equipment is repaired that had been originally entered into a ships CSMP through SMAF reports, the AEC will not know this until the next PMT ship visit. This makes the use of the outstanding SMAF reports not feasible as a serious, "real time" feedback system. [Ref. 5]

C. CLASS MAINTENANCE MONITORING SYSTEM (CMMS)

This is the system that PERA uses to adjust the Class Maintenance Plans (CMP) for all ships that use them as part of their Maintenance Strategies (e.g. EOC or Progressive Maintenance). The best definition for CMP is a list of maintenance oriented actions, for specific classes of ships, that are compiled from engineering analysis. These maintenance actions are time directed by the PERA Surface organization and are part of their Long Range Maintenance Schedule (LRMS). The LRMS is one of the initial inputs into PERA's SARP preparation for any ship. The CMP from the LRMS, like the CSMP, is a major input document into the baseline SARP. As with any engineering system that tries to predict the timing of equipment failure, the CMP has a system that is used to improve its accuracy of prediction. This system is called the Class Maintenance Monitoring System (CMMS). The CMMS system takes feedback data from overhauls and analyzes that data to see whether or not an adjustment to the CMP is warranted. The following documents are used as input material for CMMS:

1. "As Found Condition" Reports. When directed by the work specifications, shipyard workers and sometimes either Supships, TYCOM or Ships Force are required to fill out an "As Found Condition" Report. The importance to the CMMS system of the "As Found Condition" Reports are that they give (if done correctly and in proper detail) PERA immediate feedback as to whether the CMP's were correct with regard to the timing of equipment maintenance. For example, if a particular CMP lists a pump as requiring a class bravo overhaul after five years due to impeller

wear, then the "As Found Condition" Report should list some wear on the impeller when the pump casing is opened. If the impeller does not show any signs of wear, this could be one clue that this particular CMP line item may require some type of time adjustment. This adjustment would be accomplished so as to preclude premature maintenance on this particular pump.

2. Casualty Reports (CASREPS) are used within the CMMS system to identify those pieces of equipment that are failing with regularity at specific points within the machinery life cycle. Machinery that fails earlier then expected should be identified by CASREP summaries and provide a source of data for CMP adjustment through CMMS.

3. Tests and Inspections. All of the available Naval tests and inspections are used as feedback data for CMMS. The tests include LOE & OPPE's, INSURV, POT&I, Combat System Assessment (CSA's), and Combat System Readiness Review (CSRR). All of these tests, if used as intended, contain important data can that help improve the CMP's of all classes of ships.

4. Onsight Observations. PERA maintains personnel at the overhaul sight. These personnel make observations and report recommendations they have with regard to changing CMP's through CMMS. The actual process with which a ships CMP is changed is complicated Initially one or more of the fore-mentioned data sources provides evidence that an adjustment to the CMP is required. At this point in the procedure a Problem Identification Report (PIR) is generated. This report is forwarded to the Insurvice Engineering Agent (ISEA) which is usually NAVSSES or NAVELEX. These ISEA's review all of the available information (this includes technical manuals) on a particular CMP line item and then makes written recommendations. ISEA written recommendations are called Problem Analysis Reports (PAR's). The PAR reports are forwarded to NAVSEA code 914L where final changes proposed to the CMP are approved. Problems identified within the CMP, by the feedback data available, are carefully analyzed at every phase of the CMMS procedure. This attempts to lead to better decisions within the (WDC) and a more efficient and accurate input source for baseline SARP's. [Ref. 6 & 7]

It should be noted that ships in overhaul depend on CMP inputs to varying degrees. For example, those ships that are under the Engineering Operating Cycle (EOC) Maintenance strategy have approximately twenty percent of the SARP input from the CMP. However, those ships under the progressive maintenance strategy have up to eighty percent of their inputs from the CMP (FFG-7 & PHM classes) [Ref. 6]. This means that accurate and efficient CMP's are a must if the overhauls are to be successful for ships under the progressive maintenance strategy. Within this context, the CMMS system becomes critical to the FFG-7 & PHM classes as inefficiency could mean money is wasted on equipment that does not need to be repaired, and equipment that needs maintenance might receive none. Without an accurate CMP through the CMMS feedback system, ships will never be as materially sound as they could be.

D. TROUBLE SYSTEM

The trouble system was developed by Capt. Terry Glover approximately three years ago to assist the SURFLANT TYCOM staff in its decision making process for the maintenance of combat systems (SURFPAC has also just recently instituted the trouble system as well). The Trouble System is a relatively new, TYCOM operated feedback process that measures combat systems equipment readiness and assigns a maintenance priority number to each piece of equipment entered into the system. The Trouble System uses many of the same data inputs of other feedback systems. They include: Combat System Assessment's, Combat System Readiness Review's, INSURV's, and CASREP data. These data are entered into a computer program designed specifically for the Trouble System. The computer program analyzes the data provided, and identifies those systems that have shown a propensity to fail. The Trouble System computer program assigns different values to each instance when a particular inspection identifies a problem within a combat system. These values are collated and a "readiness value" is tabulated for each piece of equipment. These readiness values set up a priority listing for maintenance repair. These numbers identifies which systems are most susceptible to failure, and thus require a greater amount of maintenance. To ensure that the maintenance priority numbers are legitimate, all trouble system readiness values are screened through waterfront personnel (ISEA's & technical experts). This is considered the "reasonable man" consideration of this feedback system. In other words the computer conclusions are not just taken for granted, but presented to the experts to ensure bogus findings by the computer are screened out. [Ref. 8]

If given accurate input data, the trouble system will help the TYCOMS to prioritize systems maintenance. This feedback system could become a key tool in ensuring the efficient use of TYCOM maintenance funds, as well as increase overall systems reliability.

E. MEASURES OF EFFECTIVENESS SYSTEM

The Measures of Effectiveness (MOE) System is a feedback system developed by Naval Ship Systems Engineering Station (NAVSSES) to measure the effectiveness of the AEC program. The AEC program, as described earlier, sponsors the PMT teams to accomplish a pre overhaul visit on any ship entering into an overhaul within 60-90 days. The pre overhaul PMT test results are the cornerstone of the MOE system. The MOE system takes the results of the pre overhaul (Executive Summary) and compares it to the authorized SARP. This procedure is done in order to make recommendations on equipment that have both jobs listed in the SARP as well as in the PMT monitoring system. The comparison will shortly work electronically by PERA using its VAX computer to send a mini-SARP to the AEC VAX computer. This electronic mini-SARP contains only jobs that are evaluated by the PMT teams. The results of the Executive Summaries have recommendations for any jobs to be deferred or picked up due to the results of the AEC evaluation process. These recommendations are then written up as two-Kilos (a paper work request form used to enter jobs into the 3M system) and sent back to PERA. These recommendations are then added as a footnote within the SARP (usually listed as not supported by AEC testing). This process is designed to help ensure that jobs that are not needed but have been placed on the SARP for whatever reason (e.g. by a time directed document like the CMP) are deferred and thus saves money for jobs that really need to be accomplished. This process is another effort to ensure a move to a higher percentage of condition based maintenance and less time directed maintenance. [Ref. 9 & 10]

The MOE program also attempts to measure cost savings that are realized by recommendations made by the AEC program. This is accomplished by listing all of the jobs that were deferred due to recommendations from the AEC. The projected costs of the deferred jobs are compiled and itemized to display a savings per job deferred listing. By this system, an estimate of funds saved by the AEC program can be computed. [Ref. 9 & 10]

The last component of the MOE program is to measure the decisions recommended by the AEC program. This i. currently performed on a small scale by reviewing "As Found Condition" Reports to determine if the actual condition of equipment matches the findings of the AEC organization. For example, if an AEC Executive Summary recommends deferral of a particular job, the "As Found Condition" Reports should validate this decision. This method is an excellent procedure for determining the accuracy of decisions made on the recommendations made by the AEC Organization. [Ref. 9]

The only problem with this procedure is that it cannot be accomplished by a computer due to the fact that "As Found Condition" Repor+- are not entered into any computer data base. Further, this procedure only reviews those decisions made on the recommendations made by the AEC organization.

F. MAINTENANCE REQUIREMENT SYSTEM

The Maintenance Requirement System (MRS) is a computer software program developed by the American Management Systems Corporation (AMS) for NAVSEA-915. MRS is a process that "clearly defines the Maintenance Requirements for surface ships, assists in preparing and justifying the maintenance budget to provide funding to execute those requirements, and assesses the potential impact of funding below that level."[13] This is accomplished in three phases. First, the maintenance required to be accomplished during an availability must be determined so as to provide for the safe and reliable operation of the ship during its follow on operating cycle. Second, these maintenance requirements must be accurately predicted over the POM years to ensure adequate funding is established to execute those requirements. Third, given that adequate funding at the required level may not be available, the impact of funding to a lower level with respect to the surface Navy's ability to carry out its assigned missions must be identified. [Ref. 11]

The first phase of this process is to identify all of the maintenance procedures required by ships in order that operational goals can be accomplished. The total maintenance requirements assembled and presented by PERA surface to the

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[13] Williams Robert Luke, Director of Surface Ship Maintenance, Maintenance Requirements System brief, September 1991.

type commander can be divided into two categories: fixed and variable. "The fixed inputs are made up of time directed technical requirements (i.e. CMP's), standard shipyard routines, and SHIPALTS."[14] The variable inputs are those maintenance requirements where the scope of work is based upon the actual material condition of the equipment, based on tests and inspections conducted during the planning phase of the overhaul (i.e. PMT's). The fixed and variable inputs are used by PERA to make up the preliminary SARP. The preliminary SARP compiled by PERA also adds man-day estimates and man-day rates to produce a proposed SARP. The proposed SARP is the document that embodies most of the required information for the first phase of the MRS system. However, the proposed SARP does not show deferred work or growth and new work. To include this information the completion SARP must be used. Once an availability is completed and a completion SARP is compiled, this information is used to develop a representative availability. By using the completion SARP to build a representative availability, the MRS system will have an accurate listing of all of the maintenance requirements a ship needs to accomplish mission objectives during the follow on operational cycle. With this in mind, the first data input into the MRS system must be from the PERA VAX computer (Equipment History Files) in constructing this representative

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[14] IBID.

availability. The information provided by this data source includes: fixed and variable SARP inputs, SWLIN[15], SWLIN manday estimates, EIC, job numbers, mandays, material, and frequency. These inputs form the base of the MRS system and document the maintenance standards and projected costing for these maintenance standards required to carry out ships missions. [Ref. 11]

The second phase of the MRS system is to support the Program Objective Memoranda (POM) for Surface Ship Maintenance. This is done by comparing the phase one inputs (maintenance requirements and costing of these requirements) to scheduled availabilities and probability of failure estimates. Using quarterly 3M and CASREP data (transferred by tape diskette), the MRS system computes the probability for systems to fail over time. This probability factor in the MRS system is designated as "Pf". "Pf" is a numerical value for the "Need for Repair" per system, and can be used as an estimate for the probability for specific systems to fail in the future. The estimated cost of repair information is now added to the probability factor. The resultant information is an estimate of how often systems equipment will require

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[15]Ship's Work Line Item Number, "SWLIN",is a term used to refer to a specific unit of work defined in the SARP. The SWILN is identified by the four digit SWAB Number, and a one digit number that identifies the reporting level breakdown within each SWAB.
**Note "SWAB" stands for Ships work Authorization Boundary. This four digit number identifies specific systems to be worked on in a depot level environment.

repair, and how much these repairs will cost. The MRS system then adds ship availability and scheduling data from the FMPMIS system. With the scheduling data, repair probabilities, and costing data all within one data base, it is possible to estimate overall maintenance availability costing in the out-years and thus support the POM process. This accomplishes the second phase of the MRS system: to show a justification for the requirement of maintenance funding for the federal budget process. [Ref. 11]

The third phase of the MRS system deals with quantifying the risk associated with funding below the level required to accomplish necessary repairs as identified in the first phase. Like the other two phases, the third phase uses the information from the first two phases compiled with new information to accomplish its goal. From OPNAVINST C3501 series and OPNAV Note 4700, the system importance, mission elements, mission criticality, and maintenance strategy designation all are entered into the MRS database. The compilation of this information becomes the severity factor (Sf). This severity factor shows the result upon mission areas when specific equipment is out of commission or degraded. The severity factor is used in conjunction with the probability factor (Pf) described earlier to compute the "risk" of reduced funding in the area of surface ship maintenance per specific work items (SWLIN's). Specifically, the risk (R) of reducing funds for surface ship maintenance can be annotated as follows: significance of outcome (Sf), multiplied by the likelihood of the outcome (Pf) or R=Sf x Pf.

This computation of risk, considering the present constrained funding environment is critical. TYCOM, the fleet, and OPNAV could be much more capable of managing a reduction in maintenance funding with the information provided by the MRS system. With regard to risk management, the MRS system can provide the following information per SHIPSHEET for a specific availability:

1. SWLIN's sorted by cost.
2. SWLIN's sorted by severity.
3. SWLIN's sorted by probability.
4. SWLIN's sorted by risk.

This information identifies the impacts of reduced funding for:

- Surface force availabilities deferred to the next fiscal year.
- Ships by class.
- Specific ships. [REF. 11]

The items and the impacts of those items affected by reduced funding may be reviewed with this information, and changes in mission requirements may be instituted as a function of reduced spending. Any management decision process must understand the "impacts" of decision options. With the

MRS system, budgeting decisions for Surface Ship Maintenance may be made with an understanding as to the "risks" of those decisions. The information that the MRS system provides increases both the economic and operational efficiency of the decisions being made within the Surface Ship Maintenance Program.

In reviewing all of the feedback systems cited above it is evident that each one has a purpose with respect to improving some element of the Surface Ship Maintenance Program. The Corporate Data base looks at costing data, the AEC reviews material condition after overhaul, the CMMS system adjusts the CMP, the Trouble System identifies combat system that break down with a high degree of regularity, and the MRS system assesses failure and risk at different funding levels for use in the POM and budget processes. Although all of these processes serve as a part in the refinement of the Surface Ship Maintenance Program none of them qualify as a system that **assesses the adequacy of ship maintenance in the post repair availability period.** This finding addresses the first question posed in this thesis. There is no unique system that measures the adequacy of ship repair once the availability period is over. Further, this finding also answers the second thesis question: **Is the existing assessment process suitable to judge the correctness of the planning decisions made for ships' maintenance and repair?.** Since, as stated earlier, the Navy has no system that currently assesses this process, the answer to this second question is also negative. If there is no feedback system then there is no way to properly judge the correctness of any planning decisions made during planned availabilities.

Since there is currently no system that completely analyzes all decisions made during ships availabilities, then the question becomes what would a system that does this look like? The model for such a system will be detailed in the next chapter of this thesis. Further, once the model has been outlined, data will be analyzed to show the type of decisions that could be made using such a model.

III. MODEL AND DATA PRESENTATION

The presentation of the feedback model that is the subject of this chapter can be broken down into four parts. The first part will be an explanation as to why specific information was chosen to be used in the model. The second section will deal specifically with the procedure used to collect the information. The third section will describe how the data was manipulated and how it is presented. The last section presents the actual results of the model.

A. MODEL DECISIONS

In developing any model the first decision is what information will be used. The decision to utilize the particular information employed in the development of this model came from a suggestion given by Commander Robert Luke Williams, Director of Surface Ship Maintenance, NAVSEA code 915. The specific suggestion was that the model should be based on Spruance and Kidd class destroyers which had gone through a regular a overhaul (ROH) in the past two years. The logic in this choice was that all of these ships have the same basic hull design, and they both use the Engineering Operating Cycle (EOC) maintenance philosophy. The number of overhauls used in the analysis was six. An effort was made to select current overhauls. At the same time, some of the more recently completed overhauls could not be used since all of the post overhaul information was not available at the time that the information was collected and analyzed. Also, there were six recent overhauls of ships in the two classes selected whose post overhaul information was primarily complete and available.

Commander Williams also listed the data that he felt should be utilized in the analysis of the decision making process within each overhaul. This information included CASREPS, PMT reports, and LOE/OPPE results. The post overhaul period used in the analysis will be a six month period that will begin roughly when the overhaul period ends. The reasoning behind using a six month period is that the follow on OPPE is supposed to occur six months after the LOE. Further, the PMT visit is supposed to occur within three months after the close of the overhaul period. Since this six month period after overhaul contains all of the required tests and inspections, it is a logical period in which CASREPS can be collected for analysis in a post overhaul assessment model. All of this feedback data is then to be compared to authorized or completion SARPS primarily with the intent to show jobs that were not authorized or deferred and then subsequently were documented (via CASREPS or other post overhaul information) as degraded or out of commission. This procedure produced the model for analyzing the decisions made in an overhaul from the perspective of information gathered after the overhaul.

B. DATA COLLECTION

The collection of information began by gathering data from the Type Commanders of which overhauls were available. This would include those done in the last two years but also that would have occurred long enough ago that the **majority** of the information would be available at the time of the writing of this thesis. As stated, six ships fell into this category and were used in the model for analysis. Once the completion dates of overhaul of the ships had been ascertained, information could then be gathered. To begin with, PERA Philadelphia (code 510) was contacted and Authorization and Completion SARPS for the ships under analysis were sent by PERA. Next, CASREP data was gathered from the NAVSEA code 915 data-bank. This data is stored on a DB-3 format by the American Management System (AMS) which is a civilian data management company. By giving AMS the after overhaul, six month time period for each ship, their computer was able to list, by ship, all of the CASREPS that occurred to that ship in that time frame. The data generated in these reports included the ship name, date of the CASREP, and the equipment identification code of the machinery that experienced failure.

PMT reports were gathered next. These were collected contacting the Atlantic and Pacific AEC (Assessment of Machinery Condition) organizations and requesting the **available** post overhaul reports for the six overhauls to be analyzed.

The last information collected was the LOE/CPPE reports. The gathering of these results, like the PMT reports, encompassed contacting the Propulsion Examining Board for both the Pacific and Atlantic Fleets.

C. DATA ORGANIZATION AND PRESENTATION

The data collected in the fore-mentioned section was organized in the following steps. The first data to be "worked" was the CASREP data. For each individual CASREP during the six months after overhaul period, the EIC was translated into the "noun name" of the equipment. The noun names of the equipment were then matched up with all of the like jobs in the relevant SARPs. This procedure was fairly simple in that the indexes in each section of every SARP are listed by equipment noun name. The procedure then became taking the equipment noun name of the CASREPS and matching them with the noun name in the SARP indexes for jobs relevant to the CASREPS. If there were any related jobs in the SARP that were deferred or not authorized that could have possibly prevented the CASREP from occurring, then these CASREPS were highlighted and placed on another list to be looked at further. This second list was given back to the AMS organization so that it could pull from its data base the more detailed CASREP verbiage for each instance. The verbiage that was retrieved gave a more detailed description with respect to the equipment failures and more accurately linked CASREPS to the related SARP jobs. For example a "CASREPed" air conditioning unit may be described in the verbiage as having an OOC motor. Further, if this same air conditioning unit had a job in the SARP that was not authorized and had a line item that included an overhaul to the same motor, this would constitute a possible error in the decision to not authorize the overhaul. These are the types of instances documented in the final section of this chapter.

Another type of data generated by the CASREP section of this model involves SHIPALTS and other configuration changes. If a CASREP is reported on a system that was newly installed during the ROH, then it is a possible that the testing requirements for the new system were not adequate. New systems should not have problems within the first few months of installation. If they do,it could mean that testing prior to the installation of the system needs to be improved. The procedure for identifying these types of situations involves simply obtaining the list of CASREPS as in the first procedure and identifying those listed CASREPS that were reported on systems that had configuration changes. The systems that were recently installed that had CASREPS will be listed at the end of the CASREP section of the final section of this chapter.

The second part of the data organization deals with extracting information from the PMT reports. Unlike the CASREPS that listed equipment deficiencies by EIC, the results of all of the PMT reports used, list the equipment by noun name. Further, equipment condition adjectives (poor through excellent) as well as machinery vibration analysis results were included. This format allows for a quicker and easier analysis of the material when matched with the relevant SARPs. The analysis involved taking all equipment listed as poor in the AEC summary or having questionable vibration results and checking for related deferred, or not authorized jobs in the SARP. This part of the procedure is very similar to the second part of the CASREP data manipulation. Any jobs listed in the SARP that could have corrected the deficiency and suspended the AEC finding were selected.

The last section of data organization involved the LOE/OPPE inspection results. Like the PMT reports, these inspection results are listed by equipment noun name. The specific deficiencies found by the PEB inspection teams, like the first two procedures, are compared to not accomplished jobs in the relevant SARPS. Any items that have matching jobs in the SARP that may have prevented a deficient finding by the inspection teams will be presented in the final result section. The data resulting from the fore-mentioned manipulations are presented in a standard format for each of the sections of feedback data. The names and hull numbers of the six ships are not listed at any time in this thesis in order to maintain confidentiality of the CASREP information used in the data manipulation and presentation. The standard format is as follows:

1. The name of the equipment and the specific deficiency (if known).

2. The related job (s) as it was listed in the SARP.

3. The source that was the input for the specific job listed in part a. For example: POT & I Profile or INSURV etc.

4. The screening recommendations by both Tycom and Pera as to the disposition of the related job.

5. The issue raised by the above information that supports the possibility that a mistake could have been made at the Work Definition Conference (WDC).

6. A subjectively assigned value as to the chances that, due to the information provided a mistake was made at the WDC. The value assigned can be either "possible" or "probable". If the assigned value is "probable" an additional information part (f) will be included to substantiate the claim. Only related jobs with very strong "ties" to the equipment deficiency will be classified as "probable".

7. Extra information related to the finding. At the end of each section for information gathered on CASREPS and PMT reports, total percentages are listed to show the amount of instances during the period listed as at least a possible WDC error.

After all of the information for all six ships is presented, an analysis is provided in tabular form.

D. DATA PRESENTATION

SHIP #1

A. CASREP FEEDBACK.

1. SRN-19 Navigation set inoperative due to short circuited power supply.

   a. Related SARP job listed as: SRN-18 Class Bravo Overhaul.

   b. SARP job source: POT & I.

   c. Tycom/ PERA Screening: Other/ Not Recommended.

   d. Issue(s) : Was the job listed in the SARP actually supposed to be listed as an SRN-19? Would the Class Bravo Overhaul have prevented the CASREP?

   e. Decision Error at WDC: possible.

2. Air Conditioning Plant #2 Motor Bearings Seized. Motor overheated and windings and insulation effected.

   a. Related SARP job listed as: Class Bravo overhaul to include overhaul of motor.

   b. SARP job source: Profile.

   c. Tycom/ PERA Screening: Not Authorized/ Not Recommended

   d. Issue (s): Would the Class Bravo Overhaul have prevented the CASREP?

   e. Decision Error at WDC: Probable.

   f. Extra information: The CASREP requests a Class bravo overhaul to be accomplished on the air conditioning motor.

3. Port anchor windlass, gear oil pump impeller destroyed due to rubbing against pump casing.

   a. Related SARP job listed as: Class Bravo overhaul to include inspection of the anchor windlass.

   b. SARP job source: Profile.

   c. TYCOM/PERA Screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have prevented the CASREP?

   e. Possible.

   f. Extra Information: The problem reported by the CASREP was discovered by inspection. This increases the possibility that the inspection called for by the related Class Bravo overhaul would have discovered the problem prior to requiring a CASREP.

4. Torpedo lift/strikedown equipment system inoperative.

   a. Related SARP job listed as: Class Bravo Overhaul to include extensive testing.

   b. SARP job source: Profile.

   c. Tycom/PERA Screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the Class Bravo overhaul have prevented the CASREP?

   e. Decision error at the WDC: possible.

5. Rust sediment viewed in forward main reduction gear of number two main engine.

   a. Related SARP job listed as: Clean and flush casing free of condensation rusting. Hone and polish minor debris, track in upper first outboard pinion.

   b. SARP job source: POT&I/MI.

   c. Tycom/PERA screening: Deferred/Not Recommended.

   d. Issue (s): Would the clean and flush job recommended in the SARP have corrected the rust problem listed in the CASREP?

e. Decision Error at the WDC: Probable.

f. Extra Information: This problem was listed in the CASREP as a "long standing" problem. The CASREP did not specify which shaft was affected. However, there was only one job listed in the SARP, and it was listed for shaft number two. This is one of those problems that, if not taken care of as soon as it is discovered, could prove costly down the line. The CASREP used the description of "excessive rust" being present on most of the gear teeth. Further, the CASREP lists NAVSEACENPAC as recommending mechanical cleaning to prevent irreversible damage. The wording used in the CASREP seem to suggest that the related job as listed in the SARP should have been accomplished.

TOTAL CASREPS WITH POSSIBLE OR PROBABLE WDC DECISION ERRORS: 5.

TOTAL CASREPS THIS PERIOD: 35.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 14.2%.

6. The following equipment had jobs accomplished on them during the ROH, and subsequently had a CASREP or CASREPS reported on it within the six month post-overhaul period. The work can be in the form of SHIPALTS or jobs related to a New Threat Upgrade or any other job accomplished during the ROH that failed after the work was accomplished.

   a. SPS 49 (V5) Radar, 3 CASREPS.

   b. OY-88/SPG Radar Set Group, 2 CASREPS.

   c. AN/USQ-63 Terminals, 1 CASREP.

   d. AN/USC-40 (V) 4 Distribution Set Digital Data, 1 CASREP.

   e. Fire Control System, 1 CASREP.

   f. AN/UYK-20X (V) Data Processing, 1 CASREP.

   g. Converter Signal Data, MK72 MOD15, 1 CASREP.

TOTAL CASREPS OF SYSTEMS WORKED ON IN ROH: 10

TOTAL CASREPS THIS PERIOD: 35.

PERCENTAGE OF COMPLETED JOBS THAT HAD CASREPS: 28.5%.

B. PMT DATA.

1. Seawater temperature gauge is out of calibration on #1 air conditioning plant.

   a. Related SARP job listed as: Class Bravo overhaul to include calibration of all gages and thermometers.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the calibration described in the SARP class Bravo overhaul have prevented the PMT finding?

   e. Decision error at the WDC: Probable.

   f. Extra Information: Seawater temperature gauges are important to the efficiency measurements of air conditioning units. It is therefore reasonable to assume that the seawater temperature gauge would have been calibrated if this job had been accomplished.

2. Air conditioning plant # 2 Out of commission due to vanes control arm would not retract or extend.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SAPP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem and, was the scope of the job authorized to fix any problems discovered?

   e. Decision error at the WDC: Possible.

3. Air conditioning plants # 1-4 have high difference between condenser seawater outlet and condensing refrigerant indicating fouled condenser tubes or presence of non-condensibles in the refrigerant side of condenser.

   a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem and, was the scope of the job authorized to fix any problems discovered?

e. Decision error at the WDC: Possible.

f. Additional information: Class Bravo overhaul was accomplished for all four air conditioning plants condensers. However, the scope listed cleaning for the sea water side of the condenser only.

4. Flexible connections on #2 Evaporator are out of calibration.

a. Related SARP job listed as: Class Bravo overhaul to include the replacement of all flexible hose assemblies.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the job listed in the SARP have replaced all of the out of date flexible hose connections on # 2 Evaporator?

e. Decision error at the WDC: Possible.

5. #1 HPAC had improperly calibrated gauges as well as requiring the replacement of the sea water temperature indicator.

a. Related SARP job listed as: Class Bravo overhaul to include the calibration of all gauges.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the job listed in the SARP have calibrated all of the improperly calibrated gauges. Secondly, would the Class Bravo overhaul have discovered the faulty temperature indicators?

e. Decision error at the WDC: Possible.

6. #2 HPAC has improperly calibrated gauges. Further, the HPAC in its operational test exhibited symptoms of having faulty switches and relays.

   a. Related SARP job listed as: Class Bravo overhaul to include the calibration of all gauges.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the job listed in the SARP have calibrated all of the improperly calibrated gauges? Secondly, would the faulty components have been discovered during the class Bravo overhaul?

   e. Decision error at the WDC: Possible.

   f. Additional Information: #2 HPAC had a different class bravo overhaul accomplished that was called for in the SARP by the POT&I. The question then becomes: Was the class bravo overhaul listed by the POT&I less thorough than the one called for by the profile?

7. #1 Bilge pump has narrowband vibration which indicates pump internal wear/looseness.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have prevented the PMT vibration analysis finding?

   e. Decision error at the WDC: Possible.

   f. Additional Information: #1 bilge pump was identified by the POT&I as requiring a class bravo overhaul. This was screened to IMA/SF. The question then becomes did the repairing entity have the experience necessary to properly accomplish the overhaul. Further, could the shipyard have avoided the PMT MVA finding if the more extensive class Bravo overhaul had been screened to it as part of their authorized work package?

8. Lube oil purifier #2 has narrow band vibration indicates imbalance condition.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have prevented the PMT vibration analysis finding?

   e. Decision error at the WDC: Possible.

   f. Additional Information: #1 L/O purifier listed as having the same problem. However, although this purifier was denied a full blown class bravo overhaul, it was listed in the authorized SARP as being approved for a lesser scale overhaul to be accomplished by the shipyard. The question then becomes: Would the more extensive overhaul really have made any difference since the smaller scale overhaul resulted in the same problem?

TOTAL PMT RESULTS WITH POSSIBLE OR

PROBABLE WDC DECISION ERRORS: 8.

TOTAL EQUIPMENT LISTED IN PMT REPORT: 50.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 16%.

Note The Post Overhaul PMT Report used for this ship is not an executive summary. The reason for this is that this PMT report was compiled prior to the change to the executive summary format. (Prior to the change to the Executive Summary format approximately three years ago, the AEC organization

used a different reporting format that was not as "user friendly").

C. LOE/OPPE FEEDBACK.

LOE:

1. #2 Lube Oil Purifier temperature regulating valve inoperative.

    a. Related SARP job listed as: Class Bravo overhaul.

    b. SARP job source: Profile.

    c. Tycom/PERA screening: Not Authorized/ Not Recommended.

    d. Issue (s): Would the class Bravo overhaul have prevented the PEB listing this discrepancy during the LOE?

    e. Decision error at the WDC: Possible.

    f. Additional Information: #1 L/O purifier listed as having the same problem. However, although this purifier was denied a full blown class bravo overhaul, it was listed in the authorized SARP as being approved for a lesser scale overhaul to be accomplished by the shipyard. The question then becomes would the more extensive overhaul really have made any difference, especially since the smaller scale overhaul resulted in the same problem?

2. #1 Bilge pump listed as item of priority.

    a. Related SARP job listed as: Class Bravo overhaul.

    b. SARP job source: Profile.

    c. Tycom/PERA screening: Not Authorized/ Not Recommended.

    d. Issue (s): Would the class Bravo overhaul have prevented the PEB finding during the LOE.

    e. Decision error at the WDC: Possible.

f. Additional Information: #1 bilge pump was identified by the POT&I as requiring a class bravo overhaul. This was screened to IMA/SF. The question then becomes did the repairing entity have the experience necessary to properly accomplish the overhaul? Further, could the shipyard have avoided the PMT/MVA finding if the more extensive class Bravo overhaul had been screened to it as part of their authorized work package?

OPPE:

1. Air conditioning plant # 2 out of commission.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem and, was the scope of the job authorized to fix any problems discovered?

   e. Decision error at the WDC: Possible.

   f. The ship listed the air conditioning plant as OOC prior to the exam commencing. This is all of the information available and, as such, especially in this situation, it would be difficult to prove or disprove whether a class bravo overhaul would have circumvented the A/C plant from being listed as OOC at the beginning of the exam.

2. #1 Fuel purifier and transfer pump was listed as OOC at the completion of the exam.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have prevented the PMT vibration analysis finding.

e. Decision error at the WDC: Possible.

f. Additional Information: #1 L/O purifier was denied a full blown class bravo overhaul. It was listed in the authorized SARP as being approved for a lesser scale overhaul to be accomplished by the shipyard. The question then becomes: Would the more extensive overhaul really have made any difference? Especially since the smaller scale overhaul resulted in the same problem.

Note The follow-on OPPE was not accomplished until 13 months after the completion of the LOE. This creates doubt as to whether or not the information compiled from the OPPE is relevant in comparison to the overhaul.

SHIP #2

A. CASREP FEEDBACK.

1. Air conditioning plant had a cable arc and burn inside the cable connection box on motor.

   a. Related SARP job listed as: Class Bravo overhaul to include the overhaul of the motor and motor controller.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem and, was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

2. DRAI MK 10 Mod 0 indicator dead reckoning unit is inputting incorrect information to DRT.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

3. # 6 fire pump has damaged motor leads and bearings.

   a. Related SARP job listed as: Class Bravo overhaul to include the pump and the motor.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

   f. Additional Information: There was another class bravo overhaul recommended by the POT& I that **was** accomplished. The question then becomes if the CMP recommended overhaul had been accomplished instead of the POT & I overhaul, would the equipment deficiency still have been reported?

4. AN/URN 20D (V) 1 TACAN inoperative.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

TOTAL CASREPS WITH POSSIBLE OR PROBABLE WDC DECISION ERRORS:

4.

TOTAL CASREPS THIS PERIOD: 36.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 14.2%.

6. The following equipment had jobs accomplished by shipyard workers or outside contractors during the ROH, and subsequently had a CASREP or CASREPS reported on it within the six month post-overhaul period. The work can be in the form of SHIPALTS or jobs related to a New Threat Upgrade or any other job accomplished that would be related to changing the shipboard configuration of the vessel during the ROH.

a. Helicopter Hangar, 1 CASREP.

b. SQQ89 VT1 Trainer, 1 CASREPS.

TOTAL CASREPS OF SYSTEMS WORKED ON IN ROH: 2

TOTAL CASREPS THIS PERIOD: 36.

PERCENTAGE OF COMPLETED JOBS THAT HAD CASREPS: 5.5%.

B. PMT RESULTS.

1. #2 Air conditioning plant listed in executive summary as poor. a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered.

e. Decision error at the WDC: Possible.

f. Additional Information: There was another class bravo overhaul recommended by the POT& I that **was** accomplished. The question then becomes if the CMP recommended overhaul had been accomplished instead of the POT & I overhaul, would the equipment deficiency still have been reported?

2. #3 Air conditioning plant is missing condenser zincs.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

   f. Additional Information: There was another class bravo overhaul recommended by the POT& I that **was** accomplished. This class B overhaul accomplished by the POT & I was listed as an overhaul of the seawater condenser. An additional question then becomes why didn't the overhaul that was accomplished recognize that the zincs of the condenser require replacement?

3. #1 Air conditioning plant is missing condenser zincs. Further, the data collected on the system indicates an overcharge of refrigerant in the plant.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

f. Additional information: Problems were documented on SMAF reports.

4. #2 Fire Pump discharge valve leaks internally.

a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

f. Additional information: Problems were documented on SMAF reports. Also, SARP had a job listed as "inspection of the fire pump" that was screened to ships force. The question then becomes was the decision to cancel the major class bravo overhaul in favor of a ships force inspection a correct one?

TOTAL EQUIPMENT LISTED IN PMT REPORT: 115.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: .03%.

C. LOE/OPPE FEEDBACK.

LOE:

There were no material discrepancies found in the LOE that could be tied directly to any jobs listed in the Authorized SARP.

OPPE:

1. #1 Gas Turbine Generator has high vibrations.

   a. Related SARP job listed as: Inspect bearings take and record bearing clearances. Also, hone and polish journals in way of bearings.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the inspection of the bearings have discovered the problem, and would the honing and polishing of the bearings have pre-empted the PEB finding?

   e. Decision error at the WDC: Possible.

2. #1 fuel oil filter coaleser did not shift and was labeled degraded.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

3. #1A Gas Turbine Module fuel oil quick closing valve did not trip.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

4. #3 air conditioning plant has a chill water leak.

a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem,and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

5. #2 Air Conditioning plant listed as degraded for bleed air pipe repair.

a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

SHIP #3

A. CASREP FEEDBACK.

1. Torpedo strike down system inoperative due to hydraulic leaks.

   a. Related SARP job listed as: SHIPALT that would modify existing Torpedo handling system to stow and handle MK 50 torpedoes.

   b. SARP job source: NAVSEA ALT.

   c. Tycom/PERA screening: Deferred/ Not Recommended.

   d. Issue (s): Would the NAVSEA ALT have precluded the hydraulic breakdown that was reported on the existing system?

   e. Decision error at the WDC: Possible.

2. 1A Steering Pump operating at below acceptable discharge parameters.

   a. Related SARP job listed as: Inspection of Steering Gear System.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Deferred/ Shipyard.

   d. Issue (s): Would the inspection have discovered the problem in time to have fixed the pump prior to the ship leaving the shipyard?

   e. Decision error at the WDC: Possible.

3. 2B Steering Pump has a leak in oil cooler.

   a. Related SARP job listed as: Inspection of Steering Gear System.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Deferred/ Shipyard.

   d. Issue (s): Would the inspection have discovered the problem in time to have fixed the pump prior to the ship leaving the shipyard?

   e. Decision error at the WDC: Possible.

TOTAL CASREPS WITH POSSIBLE OR PROBABLE WDC DECISION ERRORS:

3.

TOTAL CASREPS THIS PERIOD: 48.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 6.2%.

6. The following equipment had jobs accomplished by shipyard workers or outside contractors during the ROH, and subsequently had a CASREP or CASREPS reported on it within the six month post-overhaul period. The work can be in the form of SHIPALTS or jobs related to a New Threat Upgrade or any other job accomplished that would be related to changing the shipboard configuration of the vessel during the ROH.

   a. AN SLQ 32 (V) 3 CASREPS.

TOTAL CASREPS OF SYSTEMS WORKED ON IN ROH: 3

TOTAL CASREPS THIS PERIOD: 48.

PERCENTAGE OF COMPLETED JOBS THAT HAD CASREPS: 6.5%.

B. PMT RESULTS.

None of the items listed in the Executive Summary had jobs that were either cancelled or deferred in the Work Definition Conference. However, three fire pumps had class bravo overhauls that were accomplished by the **shipyard.**

TOTAL EQUIPMENT LISTED IN PMT REPORT: 104.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 0%

C. LOE/OPPE FEEDBACK.

LOE:

There were no material discrepancies found in the LOE that could be tied directly to any jobs listed in the Authorized SARP.

OPPE:

1. #1 Lube Oil Duplex Strainer was listed as an item of priority - interlock was listed as an item of priority.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Shipyard

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

SHIP #4

A. CASREP FEEDBACK.

1. Waste Heat boiler #2 Recirculating Pump inoperative.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Ship's force/ Shipyard

   d. Issue (s): Would the class Bravo overhaul, if screened to the shipyard instead of to ship's force have precluded the CASREP?

   e. Decision error at the WDC: Possible.

2. Ammunition Elevators #1 & 2 inoperative due to faulty limit switches and overspeed governors.

a. Related SARP job listed as: Install under car interlocks, overspeed governor.

b. SARP job source: POT & I/MI.

c. Tycom/PERA screening: Ship's force/ Not Recommended

d. Issue (s): Would the installation of the limit switches and new overspeed governor have precluded the CASREP?

e. Decision error at the WDC: Probable.

f. Additional Information: The problems experienced with the limit switches and governors would have been avoided if the related job had been accomplished as the defective parts would have been changed out.

TOTAL CASREPS WITH POSSIBLE OR PROBABLE WDC DECISION ERRORS:

2.

TOTAL CASREPS THIS PERIOD: 23.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 8.6%.

6. The following equipment had jobs accomplished by shipyard workers or outside contractors during the ROH, and subsequently had a CASREP or CASREPS reported on it within the six month post-overhaul period. The work can be in the form of SHIPALTS or jobs related to a New Threat Upgrade or any other job accomplished that would be related to changing the shipboard configuration of the vessel during the ROH.

a. Torpedo Handling System. 1 CASREP.

TOTAL CASREPS OF SYSTEMS WORKED ON IN ROH: 1

TOTAL CASREPS THIS PERIOD: 23.

PERCENTAGE OF COMPLETED JOBS THAT HAD CASREPS: 4.3%.

Note At the time of the gathering of the information for this ship, only five months had elapsed since the ship got out of the yards. As a result the CASREP data encompasses only five months after the end of the overhaul period.

B. PMT RESULTS.

At the time of the gathering of the information for this ship the follow-on PMT report had not been accomplished and so the data was not available.

C. LOE/OPPE FEEDBACK.

LOE:

There were no material discrepancies found in the LOE that could be tied directly to any jobs listed in the Authorized SARP.

OPPE:

At the time of the gathering of information for this ship, the follow-on OPPE had not been accomplished and so the data was not available.

<u>SHIP #5</u>

A. CASREP FEEDBACK.

There were no material discrepancies found in the CASREP information that could be tied directly to any jobs listed in the Authorized SARP.

1. The following equipment had jobs accomplished by shipyard workers or outside contractors during the ROH, and subsequently had a CASREP or CASREPS reported on it within the six month post-overhaul period. The work can

be in the form of SHIPALTS or jobs related to a New Threat Upgrade or any other job accomplished related to changing the shipboard configuration of the vessel during the ROH.

a. SLQ 32 (V)3, 3 CASREPS.

TOTAL CASREPS OF SYSTEMS WORKED ON IN ROH: 3

TOTAL CASREPS THIS PERIOD: 64.

PERCENTAGE OF COMPLETED JOBS THAT HAD CASREPS: 4.6%.

B. PMT RESULTS.

There was no PMT report available for this post overhaul period.

C. LOE/OPPE FEEDBACK.

LOE:

No material discrepancies found in the LOE that could be tied directly to any jobs listed in the Authorized SARP.

OPPE:

No material discrepancies found in the OPPE that could be tied directly to any jobs listed in the Authorized SARP.

Note The original OPPE was graded as unsatisfactory due in part, to material discrepancies. The repeat OPPE also had no discrepancies that could be linked to any jobs listed in the Authorized SARP.

SHIP #6

A. CASREP FEEDBACK.

1. Starboard Anchor Windlass/Capstan Pump is inoperative.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Possible.

   f. Additional Information: CASREP states that pump requires a complete overhaul. The CASREP also states that a complete tear down will be necessary to effect repairs on the pump.

2. Port Boat Davit has cracks on welds of an arm stop.

   a. Related SARP job listed as: Class Bravo overhaul to include inspecting Arms and Davits for cracks.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Probable.

   f. Additional Information: The class bravo overhaul had a line item to inspect for cracks.

3. Fire pump (un-numbered in CASREP) is inoperative due to sheared coupling.

   a. Related SARP job listed as: Class Bravo overhaul.

   b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

f. Additional Information: All of the fire pumps were scheduled for class bravo overhauls, and were not authorized by the Type Commander.

4. AN/SPS 55 Radar Set inoperative.

a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

5. Fresh Water Flushing Pumps # 1 & 2 are out of commission due to shafts being deteriorated beyond repair.

a. Related SARP job listed as: Class Bravo overhaul, to include overhaul of motor.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

6. #2 Controllable Reversible Pitch Propeller.

a. Related SARP job listed as: Class Bravo overhaul, to include overhaul of motor.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

7. 1B Propulsion Brake Clutch Assembly leaking oil beyond acceptable limit.

   a. Related SARP job listed as: Class Bravo overhaul, to include replacing gaskets, sealings, and fasteners.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Probable.

   f. Additional Information: The finding of an inspection by SIMA was that it was faulty oil seals in the clutch assembly that created the casualty. 1B Clutch Brake assembly was the subject of at least two separate CASREPS listing oil leakage as the problem.

8. 1A Propulsion Brake Clutch Assembly leaking oil beyond anacceptable limit.

   a. Related SARP job listed as: Class Bravo overhaul, to include replacing gaskets sealings and fasteners.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC. Probable.

f. Additional Information: The finding of an inspection by SIMA was that it was faulty oil seals in the clutch assembly that created the casualty.

9. 1A Propulsion Brake Clutch Assembly has faulty Control 500 card.

a. Related SARP job listed as: Class Bravo overhaul, to include replacing all Control 500 cards.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Probable.

f. If the Control 500 Cards had been changed out as part of a class bravo overhaul, this CASREP would probably never have occurred.

TOTAL CASREPS WITH POSSIBLE OR PROBABLE WDC DECISION ERRORS:

10

TOTAL CASREPS THIS PERIOD: 36.

PERCENTAGE OF POSSIBLE OR PROBABLE WDC ERRORS: 27.7%.

10. The following equipment had jobs accomplished by shipyard workers or outside contractors during the ROH, and subsequently had a CASREP or CASREPS reported on it within the six month post-overhaul period. The work can be in the form of SHIPALTS or jobs related to a New Threat Upgrade or any other job accomplished that would be related to changing

the shipboard configuration of the vessel during the ROH.

a. AN/SPS- 48 E Radar Set, 2 CASREPS.

b. AN/SPS (V) 5 Radar Set, 2 CASREPS

c. OY 88/ SPG Radar Group, 2 CASREPS.

TOTAL CASREPS OF SYSTEMS WORKED ON IN ROH: 6

TOTAL CASREPS THIS PERIOD: 36

PERCENTAGE OF COMPLETED JOBS THAT HAD CASREPS: 16.6%.

B. PMT RESULTS.

There was no PMT report available for this post overhaul period.

C. LOE/OPPE FEEDBACK.

LOE:

1. Propulsion Brake Clutch Assemblies leaking oil beyond an acceptable limit.

   a. Related SARP job listed as: Class Bravo overhaul, to include replacing gaskets sealings and fasteners.

   b. SARP job source: Profile.

   c. Tycom/PERA screening: Not Authorized/ Not Recommended.

   d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

   e. Decision error at the WDC: Probable.

   f. Additional Information: This problem was one of the main reasons (materially) that this ship failed the LOE.

2. LP Air Dehydrators were listed as items of priority.

a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered.

e. Decision error at the WDC: Possible.

3. HP Air Compressors were listed as items of priority.

a. Related SARP job listed as: Class Bravo overhaul.

b. SARP job source: Profile.

c. Tycom/PERA screening: Not Authorized/ Not Recommended.

d. Issue (s): Would the class Bravo overhaul have initially discovered the problem, and was the scope of the overhaul authorized adequate to fix any problems discovered?

e. Decision error at the WDC: Possible.

RE-LOE/ OPPE:

There were no material discrepancies found in the RE-LOE or the OPPE that could be tied directly to any jobs listed in the Authorized SARP.

TOTALS FROM RESEARCH FINDINGS.

1. TOTAL INSTANCES WHICH RESULTED IN A FINDING OF POSSIBLE OR PROBABLE WDC ERRORS: 46.

2. TOTAL INSTANCES THAT LISTED A CLASS BRAVO OVERHAUL AS THE RELATED SARP JOB: 41. PERCENTAGE: 89%.

3. TOTAL INSTANCES THAT LISTED "PROFILE" AS THE SARP JOB SOURCE: 42. PERCENTAGE: 91%.

4. TOTAL INSTANCES THAT LISTED "POT & I" AS THE SARP JOB SOURCE: 3. PERCENTAGE: 7%.

5. TOTAL INSTANCES IN WHICH POSSIBLE/PROBABLE DESIGNATOR WERE ASSIGNED: 37 / 9. PERCENTAGE: 80% / 20%.

IV. ANALYSIS OF THE MODEL AND RESULTING DATA

This chapter is composed of three sections. First is a critical analysis of the Overhaul Decision Analysis System (ODAS) model that was used in this thesis. Areas of concern on all aspects of the ODAS model are addressed in this section. The second section analyzes the data provided by the model and draws conclusions supported by the findings in the data. The last section provides recommendations for a fleet wide overhaul decision analysis system as supported by the first two sections of this chapter.

A. ODAS MODEL ANALYSIS

The ODAS model compiled post overhaul data including CASREPS and PMT Post Overhaul Reports, and compared them against authorized and completion SARPS. The purpose was to find "instances" where equipment repair jobs were not authorized and subsequently were reported defective or inoperable during the six month after overhaul period. The results provided findings that could be considered possible or probable WDC errors. The purpose of accomplishing this procedure was two fold. The first reason was to demonstrate that a manual overhaul feedback system like the ODAS model was possible given the information available within the Navy. The second reason to create and apply an ODAS system is to show what the possible benefits would be to the surface ship community. Specifically, the ODAS model can be used to recommend improvements to both future Overhaul Decision Analysis Systems as well as other related procedures within the Surface Ship Maintenance program. With this in mind, an analysis of the ODAS model resulted in the following findings:

1. The raw data in the CASREP section of the ODAS model, as originally supplied by AMS, contained CASREPS that could not be analyzed. The reason for this was some of the EIC's that were listed could not be crossed over to a noun name. The cross over reference listed "unknown" for some of the CASREPS that were reported for the ships that were studied. For example, in one of the ships studied, 7.5% of the CASREPS could not be researched due to the EIC's having the "unknown" EIC designator. This inability to use certain CASREPS listed in the six month period after overhaul limits the accuracy of the findings of the model. If these CASREPS could have been crossed over to an actual system noun name, the actual number of instances where decisions were possibly in error could have been higher.

2. Only one half of the ships studied had post PMT reports available. The reason for this deficiency according to the AEC organization is scheduling. Within three months after a ship leaves the shipyard, the AEC works with the Tycom scheduling representative in an attempt to set up a PMT ship visit. The Tycom scheduling representative cannot always give the PMT teams the amount of time necessary to complete the required evolution. The result is that some ships coming out of overhaul will not have a PMT visit that could be considered a post overhaul visit. This means that any post overhaul system set up cannot count on PMT results from every overhaul.

3. The completion date of the overhaul listed in the documents used in the model did not match up across the board. For example, the completion date of overhaul listed by PERA was not always the same as the dates listed in the AEC data base. This made the process of assigning the six month after overhaul period difficult.

4. Completion SARPS were not available for all of the ships used in the model. This was a problem mainly due to the fact that the completion SARP is the only SARP that contains growth and new work. The definition of growth and new work are jobs that are expanded or added after the work definition conference has been completed. If the authorized SARP is the SARP used as the basis for comparison in the feedback model instead of the completion SARP, then any new jobs added will not be reflected in the results of the ODAS model. This could mean that equipment that had been reported as broken after the overhaul period, and found to have had a related job deferred in the authorized SARP, could have had the same job or a similar job added after the WDC. This could significantly effect the results of the model by erroneously inflating the resulting instances of possible or probable errors. For this reason, using the completion SARP as a basis for any feedback model is essential, reflecting everything that occurs during the overhaul period. The actual model used three authorized SARPs and three completion SARPs. It should be noted that by using the completion SARP there were no new jobs discovered that could be related to equipment failures during the after overhaul period. However, the chance of this occurring is still possible.

5. The model uses CASREPS which is approximately ten percent of the total discrepancies reported in the 3M system. Any post overhaul feedback system should attempt to capture all of the discrepancies reported by Navy organizations. The greater the number of material discrepancies used within any ODAS model, the closer the model will simulate actual ships material condition in the after overhaul period. This increase in the amount of discrepancies would lend greater credibility to the results of the ODAS model. Using only CASREPS for post overhaul information from the available 3M (CSMP) information overlooks other sources such as ships force discrepancy reporting that does not require a CASREP. To properly analyze any overhaul decision making system it is important to consider all of the discrepancies that were documented. To this end, instead of using CASREPS as the sole source of 3M reported equipment deficiencies, the total 3M system should be analyzed. Specifically, the CSMP should be used. The way to do this is to access the CSMP by using the MRMS data base information stored at each TYCOM. This information, that can either be retrieved by magnetic tape, modem, or paper should be used to acquire the appropriate information pertaining to the overhaul being analyzed. The discrepancies found by querying the CSMP data base

then should be compared to preferably the completion SARP. This would be a more accurate procedure for post overhaul analysis.

Another reason that CASREPS are not as desirable as CSMP data for post overhaul analysis is the political pressures associated with CASREPS. CASREPS are notorious for being reported or not reported due to the perceptions taken by some squadron commanders as well as ship's Commanding Officers that CASREPS show an "inability" of a ship to handle problems internally. This idea that CASREPS can be politically "incorrect" places doubts as to whether or not CASREPS report all of the systems failures that should be reported within the system. Again, using 3M data will reduce the political interference and as such 3M data should be used in preference to CASREP data.

6. The data used in analyzing LOE/OPPE results were not descriptive enough. The message summaries from the LOE/OPPE reports were used as feedback data. These message reports do not have the detail that other feedback sources (for example: PMT executive summaries) contain and make specific links back to related SARP jobs more difficult. The feedback system would be improved if the written results stored in paragraph form were used instead of the written message form. The problem with this procedure is that it adds a greater bulk to the feedback process making an already manual process even more time consuming.

7. The feedback process in this ODAS model is a manual procedure requiring data accumulation from many sources. For example, the SARP data is collected from PERA, PMT data is collected from AEC, etc. The first problem this creates is that the procedure is very time consuming. Collecting the data from the data sources required approximately two months for the material to be collected and delivered. After this, the manipulation of the data took another two months due to the slow nature of the process (taking the after overhaul data and comparing it back to SARP data). The data accumulation and manipulation could be accomplished easier using a computer to make the necessary comparisons, if the data could be compiled into one data base. This concept will be explored later in this chapter.

8. The process of reviewing the decisions made at the WDC is nebulous, at best, due to the "atmosphere" in which the decisions were made at the WDC. The biggest factor that affects any WDC is the financial constraints that

are part of every overhaul. Because of this, hard decisions must be made at the WDC sometimes causing jobs to be deferred even though the material evidence (POT & I or PMT report) may suggest that the job actually should be accomplished if material failure is to be avoided. Another factor that should be reviewed is the influences that may have acted on the decision making process at the WDC by upcoming inspections. Due to the negative consequences that result from failing an OPPE or LOE, many decisions at the WDC are made specifically to ensure this does not happen. These consequences include the "firing" of key engineering personnel as well as pressure applied from the squadron level towards the specific ship to improve their performance at the re-inspection.

Both factors (financial constraints and upcoming inspections) are not recorded in the SARP documentation at present with respect to why certain jobs were deferred/not authorized at the WDC. Without this information available, any evaluation that is intended to judge the decision made at the WDC must be considered incomplete and therefore almost unusable. Any system used to judge decisions must consider the additional factors that may have influenced the evaluation at the time. Therefore, any overhaul analysis system must "capture" and document the reasons as to why jobs were deferred/not authorized at the WDC. This is necessary if accurate conclusions as to the suitability of the decisions made at the WDC are to be determined.

B. ODAS MODEL DATA ANALYSIS

Analysis of the data produced by the ODAS model may be broken down into three components. The first component will be a review of some of the instances that resulted in findings of "probable" errors at the WDC. The second component will deal with results drawn from the remaining instances of the model called "possible" errors. Each of these first two components may be further broken down into two impact sections. The first impact section describes the equipment problems that result from the specific decision in question, made at the WDC. The second section considers the monetary ramifications of the same WDC decision. The third and final section analyzes the percentages compiled at the end of each section (CASREP,PMT or LOE/OPPE) and provides conclusions based on the numbers presented.

1. Firm Fixed Price Contracting

To properly consider the monetary ramifications of possible decision errors at the WDC, it is necessary to understand the atmosphere in which the Navy contracts are awarded for the six overhauls studied in this model. All six overhauls were accomplished using a firm fixed price contract that is awarded to the lowest bidder after the required specifications are announced. The specifications used by the contractors to develop their bids are those that are generated after the WDC has been accomplished and the Authorized SARP has been compiled. It is a fact that in the firm fixed price atmosphere the cost per job, as part of the packaged price of the overhaul, is lower than at any other time due to the competitive nature of public bidding for a contract award. This means that any jobs that are **required** to be accomplished at depot level should be included in the work package that is used during the bidding process. If an outside contract level job (one required to be accomplished using help from sources outside of the Navy) is not authorized at the WDC the cost will be higher if that job must be accomplished on an emergent basis **after** the overhaul has been completed. This is due to the fact that jobs which are accomplished after the completion of the overhaul are awarded without the benefit of a competitive bidding type of atmosphere. [Ref. 12 & 13]

Another characteristic of firm fixed price contracts is that any jobs that are added to the contract after the firm fixed price and specifications has been established are "priced out" at exorbitant rates. The reason for this is because the contractor has already "won" the contract and has no competition at this point. The contractor can now charge much higher rates then he would have been able to charge the government for the same job under the firm fixed price public bid environment. These added jobs, as described earlier, are called new work and are only documented in completion SARPS.

As described earlier in this chapter, information analyzed using the ODAS model did not find any instances were a job was not authorized at the WDC and then added during the overhaul as new work (thus exorbitantly increasing the cost of the work). However, in an interview with an N-4 TYCOM representative with extensive experience within the ship maintenance field, it was learned that this situation does occur frequently. **This** ODAS model unfortunately only reviewed those jobs that had an equipment deficiency reported in the after overhaul period. Therefore, jobs that were cancelled and then re-added to the work package as new work, and did not have any material discrepancy reported in the six month period after overhaul, would not have been documented within the results of this model.

With the foundation set with respect to how firm fixed price contracts effect the pricing of jobs, the analysis of the data can now follow.

2. Probable WDC Errors

The first section of data to be reviewed is the group of instances (decisions) that were considered as "probable errors" at the WDC by the model. Not every "probable" instance found by the model research is discussed in this section. This is due to the large number of cases found to have this designation. To cover each separate instance of a probable WDC error would not result in any significant increase in the actual findings obtained from the resultant data. However, key instances that are representative of the overall characteristics of these probable instances will be reviewed. When reviewing this portion of the data it is important to recognize that the designation of "probable", with respect to the decisions made at the WDC, does not take into account the **reasons** that decisions were being made at the WDC. In other words, the influencing factors discussed earlier (monetary constraints and upcoming inspections) are **not** considered in assigning the "probable" designations. This means that probable errors may have very good reasons as to why these decisions were madeat the WDC. This point must remain in context throughout the analysis of **all** of the data of the model (both probable and possible).

The first instance to be discussed is ship #1, CASREP section, #5. The problem in this instance was described as rust and sediment viewed in a reduction gear. The related job was listed as cleaning and flushing the reduction gear casing clear of rust. The seriousness of this job and the possibility of possible further damage to a very expensive piece of equipment, like a reduction gear, clearly points to the fact that this job **should** have been accomplished during the overhaul period. The impact of the decision to not accomplish this job from an equipment standpoint might have meant that the ship in question way not have been able to carry out assigned missions due to an inability to operate all of the engines at full power. This possibility is not acceptable from an operational standpoint and strongly points to the fact that the related SARP job should have been accomplished during the ROH.

Another indication that the job probably should have been accomplished is the wording listed in the remarks of the CASREP itself. NAVSEACENPAC was listed here as recommending to accomplish practically the same job that was listed in the SARP as deferred. This is a further indication that the specific decision to not authorize this job was a mistake.

From a financial perspective it appears that the decision to defer this job was also not a "good" one. As explained earlier, the job as it was listed in the SARP would have cost less for the government to accomplish in a firm fixed price atmosphere due to the competition required to "win" the contract. However, the mechanical cleaning required to alleviate the problem reported by the ship will now cost much more as it will be awarded after the overhaul has been completed. This is due to the usually higher costs associated with jobs accomplished by contractors outside of the overhaul portion of a ships cycle (this type of job is something that would probably be handled by a private contractor). The higher cost to repair this specific problem did not have to be realized if the decision had been made at the WDC to accomplish the specific job in question. This point highlights the conclusion that the decision to not accomplish this particular job might have been a mistake not only from an operational aspect but from a financial perspective as well. [Ref. 12]

The next instance is listed as ship #1, CASREP section, #2. The CASREP listed the #2 air conditioning plant as having seized motor bearings. The remarks section of the same CASREP listed a request for a class bravo overhaul to alleviate the problem. The point is that the fix requested by the ship in the CASREP is **very** similar to the job that was turned down during the WDC. This means that if the repair had been accomplished during the ROH the CASREP might never have arisen and the equipment would have been available to support any missions assigned to that particular ship. Further, the job again might have cost the government less money to accomplish if it had been done during the overhaul under a firm fixed price scenario.

The last instance to be discussed with the "probable" designation is listed as ship #6, CASREP section, #8. This CASREP was listed as the 1A propulsion brake assembly leaking oil. The same problem was also listed in the LOE section of this ship and was identified as a major contributing factor in this particular ship failing an LOE. Again, as in the first two instances, the equipment downtime and higher cost of repairing this depot level job could have been avoided if the job had been accomplished during the ROH period. However, in this instance an even greater problem arose due the decision not to accomplish this job during the ROH. This greater problem was the contribution that this decision had toward the ship failing the LOE. Although the propulsion brake assembly oil leak was not the only reason why this specific ship failed the LOE, it was, according to Propulsion Examining Board (PEB) members, a "significant" contributing factor.[Ref. 14]

When a ship fails an LOE it disrupts schedules due to the ship having to retake the LOE before it can become operational again. This means that other ships must take mission commitments for the ship that failed its LOE. This creates pressure on all of the ships involved. Further, failing an LOE requires extra money to be spent to "re-prepare" the ship to re-take the LOE. This is an expensive proposition. Lastly, the ship must now face a lot of scrutiny from its squadron as to why they failed this highly regarded exam. This adds even more pressure to an already tense situation. This decision not to do the related job at the WDC effected many aspects in relation to the ship in question ranging from cost of its overhaul, all the way through to its reputation and self esteem.

Although the instances of probable errors at the WDC only accounted for 20% of the total number of errors as listed in the research findings, the results as listed above are significant. These types of situations should be documented in a lessons learned format. The reason for this would be so if the same situation arises, the decisions resulting in the fore-mentioned problems would not happen again.

3. Possible WDC Errors

The majority of the possible WDC errors identified by this analysis are class Bravo overhauls that were called for by the CMP, and were not authorized at the WDC.

An example of this type of instance is ship #2, PMT section, #1. Specifically, the #2 air conditioning plant is listed in the PMT executive summary as "poor". The authorized SARP listed a class bravo recommended by the CMP (listed as "profile" in the SARP) and not authorized at the WDC. This scenario accounts for most of the possible instances listed in the result section of this chapter. Like the probable error section, the fact that a related job was not authorized at the WDC creates two problem areas. First, the machinery might have been fixed if the class bravo overhaul had found and repaired the equipment deficiency (during the ROH). This could have precluded the equipment deficiency as noted by the PMT report. Secondly, by not authorizing the related job to be accomplished under a firm fixed price atmosphere, any repair after the ROH is accomplished will be more expensive (if the job is screened as depot level work). [Ref. 12]

In general, in the instances of "possible" WDC errors, it is difficult to verify as an actual erroneous decision due to the fact that there is no way to tell if a class bravo overhaul would have precluded a specific equipment failure. To the contrary, according to Kenneth Jacobs, NAVSEA Director of Surface Maintenance, there is a 70% chance of equipment failure immediately following repairs being effected to any piece of machinery [Ref. 15]. This is due to repairs being improperly effected. This phenomena is called "infant death" within the field of equipment maintenance. This theory is partially supported by the results of the model. Take ship #2, CASREP section, #3, as an example. This particular CASREP on the #6 fire pump had a related SARP job listed as class bravo overhaul not authorized with its source being the CMP. The interesting point is that the SARP also showed a class bravo overhaul being authorized with its source being listed as the POT & I. Although it could be argued that the machinery failure was a result of the class bravo overhaul called for by the POT & I being less extensive then the one called for by the CMP, this does not seem plausible. This specific instance seems to be more in direct support of the infant death theory which in turn supports the fact that in some respects overhauling equipment can do more harm then good. [Ref. 15]

A similar situation occurred with ship #1, PMT section, #7. Here two overhauls were recommended (CMP and POT & I) for #1 Bilge pump, with a post PMT report listing narrow band vibration indicating internal wear and/or looseness. Again, a class bravo overhaul was accomplished with the result being equipment failure within a short period of time after repair. This further supports the infant death theory. It should be noted at this point that the only time this phenomena would be captured using this model (ODAS) is when two overhauls were recommended and one was not authorized/deferred and the other was accomplished.

The last component of the ODAS model that supports the infant death theory is the segment in the CASREP section that listed jobs which were ship configuration changes done in the ROH that had CASREPS in the post overhaul period. For example, ship #1, CASREP section, #6 listed seven systems that were added or modified during the ROH and had a casualty report listed on it within six months after the end of the overhaul. In a shipboard environment, the situation of upgrading or installing any system can be somewhat likened to overhauling that system. This supports the infant death theory by definition.

There was another type of situation identified by the ODAS model where two overhauls per equipment type were recommended in the authorized SARP. Here again, the CMP overhaul was not authorized and the other class bravo overhaul (POT & I) was accomplished. The situation this time, however, pointed to the class bravo overhaul that was accomplished being done inadequately. For example, ship #2, PMT results, #2 listed #3 air conditioning plant as missing zincs in the condenser. The interesting point is that this specific air conditioning plant had a class bravo overhaul accomplished on the condenser. It seems that any class bravo overhaul on an air conditioning condenser should have checked the zincs and replaced the deteriorated ones. The conclusion drawn here is that a less then adequate overhaul was performed.

It is evident that the "possible" section of the feedback model may not be able to point to **specific** decision errors. However, it may present evidence pertaining to other, just as important issues as described in the aforementioned instances.

4. Compiled Percentages and Other Items of Interest

In reviewing the compiled percentages listed at the end of each section (CASREP, PMT, LOE/OPPE), it is important to remember that these should **not** be measured against each other (between ships) in order to assign qualitative judgements as to the success or failure of decisions made at each specific WDC. For example, the fact that ship #2 had 14.2% possible or probable WDC errors in the CASREP section, and ship #3 had only 6.2% possible or probable errors in the same section, does not mean that the overhaul was executed better for ship #2. As described earlier, the atmosphere in which the WDC must be executed is very complicated with many diverse influencing factors. Secondly, the material requirements necessary to bring each individual ship studied up to 100% of its mission readiness is different for each individual ship. These facts mean that comparing percentages between overhauls is meaningless Therefore, the overall percentages found at the end of chapter three are more useful to suggest a basis for how many CASREPS (or per instances of PMT report or LOE/OPPE report) in an **individual** overhaul had a related job not authorized as compared to the total amount of CASREPS for the entire period after overhaul. These numbers are merely a reference point for the results compiled for each separate overhaul.

The totals from the research findings provided at the end of chapter three are included to present an overview of those items that **could** be grouped together between all of the ship overhauls that were used within the model. One very interesting item was that close to 90% of the instances found in the model had their source listed as "profile" (CMP) and were listed as a related SARP job of "class bravo overhaul". These two facts highlight a need for a change in procedure with respect to CMP's and the recommendations each one makes for accomplishing class bravo overhauls within the Surface Ship Maintenance Program. This subject as well as recommendations for an **improved** feedback model are taken up in the last section of this chapter.

C. FEEDBACK MODEL IMPROVEMENTS AND RELATED RECOMMENDATIONS

This section is broken down into two parts. First, improvements to the feedback model, as warranted by the analysis of both the process and results of the ODAS model used, are presented. Second, other recommendations, with respect to surface ship maintenance programs and procedures following from the research conducted in this thesis, are addressed.

1. Feedback Collection and Reporting System Improvements

The first problem to be addressed with respect to the ODAS model used in this thesis is that it was a non-automated process. Because of this, the execution and data manipulation of the model was extremely slow. Also, manual manipulation of the data used meant that only CASREP data would be used from the 3M system. As mentioned earlier, this comprised only 10% of the available 3M reported equipment deficiencies for any reported period of time.

The reason that the ODAS model had to be a non-automated procedure is due to the way the Navy has developed the data bases that contain the required information. All three of the major components of the after overhaul information is kept in a **separate** data base. These separate data bases were developed due to individual organizational needs without any thought to possible requirements for inter-conectivity. The first chapter in this thesis highlighted this problem by listing the sources of information and their **separate** storage points. For example: PERA stores SARP data, AEC stores PMT data and analysis, PEB stores LOE/OPPE results, Mechanicsburg stores CASREP data, and the MRMS system stores CSMP data.

These storage points for the data do have some points of connection. For example the Measures of Effectiveness program as described earlier links the PERA VAX computer with the AEC computer in order to evaluate the effectiveness of the AEC program. Also, the MRMS information is available to PERA Surface and to non connected users on request either through paper printout or magnetic tape. [Ref. 9]

Although these links serve the purpose(s) for which they are intended, they do not provide the analytical capacity to accomplish what appears to be necessary in the WDC decision feedback system. The primary reason that this is not possible is due to the fact that between both the CSMP data base (MRMS) and the PERA SARP data base there is not a common data element that could be used to accomplish the required computer query [Ref. 16], i.e., a list of all of the jobs in the CSMP that have links to any job listed in a SARP that was not authorized. The CSMP mainly lists jobs by JCN and the SARP system groups jobs mainly by SWLIN. Although the SARP also lists jobs by JSN (which could easily be cross referenced to JCN's) not every job within the SARP system is assigned a JSN. One reason for this is that some jobs are entered as emergent work into the work package and are not assigned a JSN during the planning process. Further, some jobs are entered into the SARP system without JSN's for no specific reason. To accomplish a computer query there must be a common element in both data bases to facilitate computer manipulation of the data. The easiest way to achieve commonality between these two data bases would appear be to ensure that all inputs into the SARP have an assigned JCN/JSN regardless of the input source or the timing of the input. [Ref. 16]

Further, the type of analysis required for an **effective** feedback system, as demonstrated by the ODAS model, must use <u>specific situations</u> compared against the decisions made as represented in the SARPS. The data available within the 3M system in each CSMP has a remarks section that could be used to review each situation of equipment failure against decisions made within the SARP if all of the jobs listed in the SARP could be cross-referenced to JSN's.

To this end, the easiest way to develop a computerized feedback system might be to insure all jobs in each SARP are assigned JSN's. This would create a trail that would be easier to follow from the after overhaul information (like CSMP data) back to the related SARP jobs. If JSN's were included within all of the SARP data, a computer could use the common elements (JSN's) to perform a search to find those jobs that were deferred at the WDC, and subsequently had equipment deficiencies reported in the after overhaul period. Any time a deficiency is reported on a shipboard system from any program, it is supposed to be reported within the 3M system and assigned a JSN. This includes problems identified by the following organizations and inspections: INSURV, PEB, AEC, POT & I, and ship's force. This list captures most of the sources of information available (it includes those types used in the ODAS model) for feedback in the Navy's overhaul system. To include JSN's within all of the SARP data would complete the "audit trail".

This change would mean that the CSMP data would be the only feedback required to be compared to SARP data for purposes of reviewing the decisions made at the WDC with one exception: the JSN would have to include a code attached to it that would identify the equipment system that had failed. The reason for this is that any instances where equipment deficiencies had occurred **after** the authorized SARP had been compiled would not have a JSN assigned to it that would match up with any listed SARP JSN.

However, a **related** SARP job could still not have been authorized. If the JSN had a system identification number (like an EIC) attached to it, then the aforementioned instances could be captured. This would be accomplished using a computer to compare either the JSN component, or the system identification number component between SARP jobs and reported deficiencies. This system would then be able to match up even those jobs which were originally entered into the CSMP after the authorized SARP had been compiled, by comparing equipment identification numbers back to the same numbers in the applicable SARP. The system described would output a list of possible WDC errors similar to those generated by the model used in this thesis. Analysis of each separate instance (e.g.

in the remark section of 3M system for reported deficiencies) would still be necessary due to the fact that each situation is different. The advantage to this system would be that the computer would reduce the number of instances that would have to be reviewed manually which can thereby cut costs.

To this end, there is a PAT team sponsored by OPNAV N-432, scheduled for the near future, and headed by Captain Wessman (USN) that is to review the larger problem of the 3M system. Within the purview of this PAT team is the question of how to increase traceability for jobs between Navy organizations. It is possible that the suggested changes mentioned here could result from this PAT. However, this will not be known until the PAT team is scheduled, and results from the PAT team are released. Further, there are no guarantees that this perspective will be included in the result of the PAT team. [Ref. 17]

Another type of information that would improve the feedback process is one that provides the **reason** for deferrals. At present it cannot be ascertained why a job is deferred at the WDC. The addition of a field to describe the reason that jobs are not authorized in a SARP would contribute to a feedback system, by helping to illuminate the factors considered in the WDC environment in which decisions are made. Presently, this lack of information, in some instances, appears to seriously limit the conclusions that may be drawn about the WDC decisions. If such information were available on why jobs were deferred, the feedback system would be batter able to provide significant lessons learned from each instance of what appear to be decision errors made at the WDC. [Ref. 18]

Another way to improve the present reporting procedure to better support a feedback system might be to require ship's force to report specific problems that might be considered "caused by" WDC decision errors. Ship's force should have been able to identify equipment that had experienced failure due to the deferral of jobs at the WDC. This is because ships force, out of all of the organizations involved in the overhaul process, would be the most likely organization to notice this type of situation occurring. This is due to the fact that, after the overhaul, it is ship's force that must operate the equipment. If there is any job that is denied at the WDC, for whatever reason, and a subsequent equipment failure results, the first organization to notice this would be ship's force.

Presently, the quickest and cheapest way that might be used to capture this type of information from ship's force, would be to require a statement to be made to this effect within the 3M system when these situations arise. Specifically, within the 3M maintenance manual, direction could be given that would require ship's force to report within the remarks section as to when possible mistakes were made at the WDC that adversely effected ships equipment. The statement entered into the remarks section of the 3M system would list both the problem as well as the related SARP job that was deferred.

To bolster the effectiveness of this policy, the TYCOMS should require a message to be sent from the ship to the TYCOM, as soon any piece of equipment denied a repair during a depot level availability, is discovered inoperable or degraded. The situation should then be investigated by personnel at the TYCOM staff that would be unbiased, to determine whether an actual error at the WDC had occurred. This system would highlight those jobs considered by ships force to have created a problem operationally.

The problem with this system would be the reluctance by ship's force to actually report when this type of situation occurred due to political ramifications. Since ship's crew is under TYCOM in the chain of command, and TYCOM N-4 staff has the final authorization for decisions at the WDC, reporting decision errors might be viewed as "putting your boss on report". Most commands are understandably adverse to do this. However, if the system were used to capture "lessons learned", it could improve ship maintenance and repair cost efficiency.

An additional potential improvement to any system used to analyze decisions made after overhaul would be a means to specifically review decisions that deferred a particular job and then re-added it during or after the overhaul at a higher overall cost. As discussed earlier, these situations do occur and cause the government to waste money. The higher costs are due to the higher rates charged by contractors for jobs accomplished in a non-competitive atmosphere such as the post overhaul period [Ref.12]. It seems that any overhaul decision assessment system should review these type of situations to develop a history of typical instances when this type of error occurs. This system would require both the feedback procedure described earlier using the 3M system (CSMP) as well as a procedure to look at those jobs that were re-added during the overhaul resulting in new work.

This new second section of this procedure could be accomplished by using the PERA VAX computer. The computer could simply compare either SWLIN'S or JSN's (if the information on JSN's is added to SARP data as suggested earlier in this thesis) to find any equivalent serial numbers where similar jobs had been not authorized and then re-added. This list might even be used to determine the cost of these types of mistakes. To do this, the projected cost of deferred jobs would need to be documented in the completion SARP (currently they are not). These figures then could be compared to the cost of the related new work also to be found in the completion SARP. This procedure could provide an important tool in saving resources during the overhaul cycle.

2. Other Recommendations Supported by Research Findings

Other findings resulted that may be only partially relevant to the creation of a new ships maintenance and repair feedback system. They included the following:

1. There is a definite need for a new 3M system at the shipboard level for reporting deficiencies. Presently one of the most sophisticated methods is the SNAP II system. This system allows computerized reporting of equipment deficiencies into the 3M system at the shipboard level. Unfortunately, there is still too much manual entry that must be accomplished by ship's force. Specifically, the APL and EIC must be looked up using the equipment noun name, and then entered into the SNAP II system by keyboard. This manual entry results in cross-reference errors and keyboard entry errors reducing the effectiveness of the 3M system [Ref. 18]. Also inaccurate data entries into the 3M system could result in errors for any automated system that uses these entries for data comparison. Since the feedback system recommended here uses these inputs from the SNAP II system (JSN & EIC), the accuracy of these entries become important.

   The PAT team described earlier being formed to recommend changes to the 3M system is reviewing this need. Currently, there is a plan to develop a SNAP III system that would automatically input the proper supporting data (like EIC's) thus reducing the number of errors and increase the accuracy of a feedback system supported by computer analysis. This plan will be reviewed by the PAT team for recommendations. If the SNAP III system were to be implemented, it could improve the accuracy of any system whose accuracy depended on the 3M system. [Ref. 17]

2. The instructions pertaining to the remarks section of the 3M system in the 3M manual should be adjusted to direct remarks entered into the system to be more situation specific. Presently, the remarks section within the 3M system often does not provide the specifics necessary to properly ascertain the true condition of the equipment casualties reported. For example, 3M remarks concerning a pump that is not within specific tolerances for shaft alignment may read "shaft misaligned". A more descriptive phrase listing exactly how much (by the numbers) the shaft is out of alignment would improve the feedback system described as needed in

this thesis. The reason for this is that the more specific the feedback data, the easier it is to make accurate correlations from the remarks sections to the related SARP jobs in question. [Ref. 19]

3. The "As Found Condition" Reports need to be recorded into a data base. Presently the "As Found Condition" Reports are recorded only in paper form. This limits their ability to be used beyond their initial use of adjusting CMP's through the CMMS process. After that, these reports are filed and, for the most part remain unused (with the exception of minor mechanical manipulations in feedback systems like the MOE program). By computerizing the "As Found Condition" Reports the data contained in these documents could be used to ascertain if decisions made at the WDC were accurate. Specifically, the "As Found Condition" Reports could prove if a decision to defer a job was supported by the material condition of the equipment when it was opened for inspection during the overhaul. This procedure is currently being accomplished by the MOE procedure using manual manipulation with paper "As Found Condition" Reports. If these reports were computerized using a filing system with the ability to cross-reference each report with a specific job listed in the related SARP (Much like the 3M system described earlier), the efficiency and accuracy of Navy feedback systems like the MOE program or the ODAS model would improve. [Ref. 18]

4. The CMP system that recommends class bravo overhauls needs to be reviewed and adjusted. The results of the ODAS model developed for this thesis listed class bravo overhauls recommended by the CMP as 89 percent of the related SARP jobs. These results point out the fact that when money is tight, some of the first jobs to be cut from the work package are usually the time directed class bravo overhauls. The reason for this is that these jobs are usually expensive, and there are other more important condition based jobs that have been **proven** to be in need of some sort of maintenance action. The result of this is that a high percentage of class bravo overhauls are not authorized and may be a primary cause of after overhaul period equipment failures.
To remedy this, it is necessary to reduce the number of CMP recommended, non-tailored, class bravo overhauls, and replace them with jobs that are less expensive and tailored more to the needs of the equipment deficiency. The present system of listing class bravo overhauls and then not authorizing the overhaul due to financial constraints appears to be a waste of time. It appears

that the CMP system needs to be revised to reflect the financially constrained environment in which the Surface Ship Maintenance Program operates. Surface ship maintenance can no longer afford to fix equipment by paying for repairs that are not tied specifically and clearly to the equipment deficiency. One suggestion to correct this deficiency would be to assign class "C" overhauls that are less expensive. The problem with this solution is that it is still "hoping " that overhauls will find and fix whatever problems are present. A better solution might be to inspect any piece of equipment that is listed for an overhaul by the CMP and then recommend specific tailored corrective action. This could be accomplished by giving a list of recommended CMP overhauls for upcoming ROH's to PMT and POT & I inspection teams. This would mean that CMP recommended overhauls could be replaced with the tailored repairs identified from the results of these pre-overhaul inspections. This system could eliminate the rarely used CMP class bravo overhaul inputs. This modification might increase system reliability and save money.[Ref. 15]

In conclusion, this chapter has presented analysis from the ODAS model applied to the data developed in chapter three. This chapter analysis recommended changes within the overhaul system that would appear to be of benefit for any future ship's maintenance and repair feedback system. The overall conclusion from the use of this model is that an improved overhaul feedback system is possible, but would require a significant upgrading and modernizing of the ship maintenance and repair database and decision process.

V. CONCLUSION

A. RESEARCH FINDINGS

The answers to the research questions are provided below. First, although there are many feedback systems that do accomplish a wide variety of necessary functions within the surface ship maintenance arena, none of them actually are designed to make assessments with respect to the validity of decisions made during the overhaul process.

The second research question was: Is the present system suitable to judge the correctness of the planning decisions made for ship's maintenance and repair? This question, like the first, was addressed in the second chapter. In short there is no official system at present that judges the adequacy of decisions made within the surface ship maintenance program and therefore, the present system for determining the cost efficiency of maintenance and repair work is not suitable.

B. MODEL RESULTS

The analysis of this thesis centered on the construction and application of the Overhaul Decision Analysis System (ODAS) model outlined in the beginning of chapter three. Although the model is not without weaknesses, its results proved useful in highlighting improvements for both the construction of an official overhaul decision analysis system as well as improving existing procedures within the surface ship overhaul system. Application of the ODAS model research resulted in the following findings:

1. The data to test the model had to be collected from a variety of sources. Because of this, there was no cross connection between data bases. This fact made comparison between data sources almost impossible. To this end it was necessary to collect and manipulate data manually.

2. Not authorizing jobs at the WDC level can prove costly. If a job is turned down in the competitive environment of the WDC and accomplished later during the overhaul as new growth, or after the completion of the overhaul as emergent work, the cost to the government can be greatly inflated.

3. Not authorizing jobs could lead to systems failures during surface ship operating cycles. Some of the instances examined involved jobs that, because they were not done during the overhaul, critically effected ships operating cycles in an adverse manner. Any instance that reduced main propulsion readiness, or had a negative effect on an operational test, must be viewed as unfavorable.

4. The environment in which WDC's are conducted contain many influences. These influences include financial and operational pressures that cannot be captured so as to fully document the reasons as to why decisions were made at the WDC. This fact severely limits the credibility of any post overhaul assessment system.

5. CASREP's should not be used as a sole source of 3M information for use in any feedback system. CASREPS are only approximately ten percent of the total number of reported 3M discrepancies. Further, due to political pressures enacted on the CASREP system, the results often appear not to be representative of actual shipboard equipment status on a fleet wide scale.

C. FEEDBACK SYSTEM RECOMMENDATIONS

Analysis of the model data led to the following recommendations:

1. Any ODAS process must develop an automated computerized system that has the capability to manipulate data from both completion SARPS and respective CSMP's. This would include assigning all jobs entered into the SARP data banks with JSN's to enable a computer to properly compare all of the data. Also, the JSN number system should be expanded to include a number to identify each ship system per JSN if all of the instances are to be properly identified. These steps are critical if a viable decision analysis system is to be instituted. Without an automated system, the amount of material required to be analyzed manually would be unmanageable.

2. The ODAS process should include a field that lists the reason for deferral/non accomplishment within the completion SARP as described earlier. Any feedback system should have as much information as possible pertaining to why decisions were made. In the surface ship maintenance environment, this could best be accomplished by including a field that would list the reasons for jobs not being authorized within the data found in the SARP. This one extra field of information would greatly improve the feedback system described as needed in this thesis.

3. Another important component that an overhaul decision analysis system should contain is a method to capture those instances when jobs are cancelled at the WDC and then re-added at a higher cost to the Navy at a later time. This system would act as feedback to the decision makers at the TYCOM level to reduce the number of re-added jobs. This could increase the efficiency of the decision making system both during and after depot level maintenance by curtailing money being spent on re-added jobs that could have been approved and then accomplished at the WDC for less.

4. Other findings highlighted by the ODAS model that were only partially relevant to the development of a new ships maintenance and repair feedback system include the following:

- There is a need for a new 3M reporting system that will be more user friendly.

- Ship's Company should be required to report instances of **perceived** possible WDC errors that adversely effected ships equipment.
- "As Found Condition" Reports should be entered into a computer data base to facilitate use of these data in Ships Maintenance and Repair feedback systems.
- The CMP system that recommends extensive class bravo overhauls should be adjusted in preference for a system that uses more condition based maintenance techniques in identifying equipment deficiencies.

These research findings indicate that an overhaul decision analysis system could increase both operational readiness as well as economic efficiency. Further, all of the information to do so **is** presently available. However, the construction of a Navy wide decision overhaul analysis system does have certain problems. The greatest problem may be the inability to manipulate the data due to the present separated structure of the data bases that would be required in such a system. To make all of the computer links necessary for the operation of a **useable** feedback system (e.g. linking the PERA data base with the AEC data base), significant financial resources would have to be committed. Presently, there is no organization willing to commit the resources necessary to create this feedback system.

Another problem with the formation of a post-overhaul decision analysis system is that such a system might be considered a threat to certain organizations within the ships maintenance and repair community. Any system that reports on "organizational mistakes" is usually not favorably received by the organization reported upon. With this in mind, it is evident that the organizations responsible for making or recommending decisions at the WDC would not be in favor of the creation of such a system.

Although the benefits of a better overhaul decision feedback system could be significant to the Ship Maintenance and Repair Program, the above mentioned impediments mean that such a system may not be realized in the near future. However, the possibility for increased efficiency in the Surface Ship Maintenance Program in both operational reliability and cost savings cannot be ignored. Budget pressure will eventually drive the formation of such a system.

C. AREAS FOR FURTHER RESEARCH

The following areas are suggested topics for further research:

1. The revisions being considered for the 3M system by Op-43 might be analyzed. Specifically: (a) What changes are being recommended at present? and (b) How will these changes effect the shipboard maintenance reporting system and ships maintenance and repair feedback systems?

2. An analysis should be made of the CMP recommended class bravo overhauls. This issue could be broken down into two parts: (a) What percentage of CMP recommended class bravo overhauls are not accomplished? (b) What percentage of accomplished CMP recommended class bravo overhauls result in infant death?

3. A cost and benefit analysis of jobs that were not authorized at the WDC but then were required to be done at a later time to correct equipment deficiencies could be attempted. The specific area of research would

revolve around how much money is wasted when errors in decisions are made at the WDC.

4. A comprehensive analysis of the Maintenance Requirements System (MRS) and the Measures of Effectiveness (MOE) system is needed. This research would focus on the development, operation, and projected improvements to the MRS and MOE systems.

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